NEW ENGLAND WATER WORKS ASSOCIATION.

ORGANIZED 1882.

Vol. II. Sept. 1887. No. 1.

This Association, as a Body, is not responsible for statements or opinions of any of its members.

PROCEEDINGS OF THE SIXTH ANNUAL CONVENTION,

Manchester, N. H., June 15, 16, 17, 1887.

On the first day a business meeting of the Executive Committee was held at the Hotel Windsor at 1.30 P. M. and the convention was called to order for the opening session at the Court House at 3.15 P. M., Vice President Kent of Woonsocket in the chair, who said: In the absence of President Rogers it becomes my duty to call you to order. It is not without some misgiving on my part that I shall attempt even to partially fill the place of your President, and I crave your indulgence for any shortcomings that may be apparent. Our Secretary will read a letter from President Rogers.

The Secretary read the following letter:

CALAIS, ME., June 5, 1887.

ALBERT S. GLOVER, ESQ.,
Secretary New England Water Works Association.

Dear Sir:—Having accepted an appointment to, and assumed the duties of a position which at this particular time requires my constant personal attention, I regret to say that it will be impossible for me to be present at the annual meeting of our Association to be holden in Manchester. I assure you I am very sorry to be deprived of pleasures and profits I had anticipated enjoying, but to me my duty seems clear. Trusting that the Association will excuse me and that your meeting will be one of the best you ever had.

I am yours sincerely,
H. W. ROGERS.

His Honor, Mayor Hosley of Manchester, was then escorted to the platform and presented to the convention by the Chairman. He spoke as follows:

Gentlemen of the New England Water Works Association:—The people of Manchester are always glad to have an opportunity to give a hearty reception to the citizens of other cities and towns of the country whenever they choose to pay them a visit. They are especially glad to welcome those

who, in any of the walks of life, are prominently engaged in promoting the public welfare. They were therefore greatly pleased when they learned that you proposed to honor them by holding a meeting in our midst. And now that you are here I am very highly gratified as mayor of the city to extend to you a most cordial greeting. Our people for more than a dozen years have enjoyed the blessings which flow from the introduction of a plentiful supply of pure water, and they can in some measure realize how much they are indebted to the scientific skill and energy of the members of the profession to which you belong for the success of this grand enterprise. Your meeting will be of great interest to our citizens from the reflection that, instead of being satisfied with the present results of scientific research in your department, you are banded together for the express purpose of making still higher advances in all that pertains to the discovery of the best and most advantageous supplies of water and the art of conducting it to every portion of a city or town in the most perfect manner. No object can be more worthy and honorable or more conducive to the public welfare than this. Our Superintendent will show you our water works and we shall consider it a favor to hear whatever criticism of the system you may be pleased to offer. Our great cotton manufactories, our locomotive and steam fire engine works, our schools and our well equipped fire department will be open to your inspection. And we are conceited enough to believe that but few cities in the country can show finer shade trees or straighter streets than ours. We are sometimes a little inclined to be proud of the early history of our city, for here was the home of Stark and many other Revolutionary heroes, and here their ashes repose. And the monument which the city has erected upon one of the public squares in honor of the heroes of the late war is an object of profound interest to our citizens. We hope gentlemen, that the meetings of your association and your visit to our city will be satisfactory and agreeable to all.

The Chairman. In behalf of the New England Water Works Association I thank you, Mr. Mayor, for your cordial welcome, and through you the city of Manchester for its generous hospitality. We have gathered here at the invitation of one of our most popular members, your Superintendent, Mr. Walker, to discuss those questions most intimately connected with the introduction and furnishing of a supply of pure water to the cites and towns which we represent, trusting that by an interchange of thought and methods we may better serve the best interests of all. I regret exceedingly the absence of our President, Mr. Rogers, who, were he here, would respond to your words of welcome in more fitting terms than I am able to do, but I beg to assure you of our hearty appreciation of your courtesy. The first business before us, gentlemen, is the reading of the records.

On motion of Mr. Hathaway the reading was dispensed with.

REPORT OF THE SECRETARY.

Secretary Glover submitted the following report:

ALBERT S. GLOVER, SECRETARY,

IN ACCOUNT WITH THE

NEW ENGLAND WATER WORKS ASSOCIATION.

DR.

To amount received as follows:		
From initiation fees,	$60.00	
" dues,	341.00	
" sale of transactions,	63.50	
" advertising,	872.00	
Total Receipts,		$1,336.50

CR.

By amount paid Edwin Darling, Treasurer,	$1,336.50

Respectfully submitted,

ALBERT S. GLOVER, Secretary.

Manchester, June 15, 1887.

On motion of Mr. Sherman the report was received and placed on file.

REPORT OF THE TREASURER.

Treasurer Darling submitted the following report:

EDWIN DARLING, TREASURER,

IN ACCOUNT WITH THE

NEW ENGLAND WATER WORKS ASSOCIATION.

1886, June meeting, DR.

To cash in Savings Bank,	$143.75	
Cash on hand,	153.11	
		$296.86
Dec. 15. To Cash Received of A. S. Glover, Secretary,		250.00
1887.		
Mar. 18. " " " "		150.00
July, 1886. Interest on deposit,		2.86
Jan. 1887. " "		2.92
June 15, 1887. Cash received from A. S. Glover,		702.64
Secretary,		936.50
		$1,639.14

CONTRA CREDIT.

1886.		
July 2. By bill paid Acushnet Lodge, No. 41, I. O. of O. F.	$30.00	
By bill paid Edwin Dews,	.70	
" " Briggs & Lawrence,	7.00	
Nov. 12. " " J. S. Sampson,	196.55	
Jan. 8, '87. " " G. H. Walker & Co.,	45.00	
" " " " Wm. R. Billings,	14.82	

March 17.	By bill paid	J. S. Sampson,	86.10		
" 21.	" "	Forbes & Co.,	35.00		
June 10.	" "	C. A Hack & Son,	44.00		
" 15.	" "	on Sec'y vouchers,	389.08		
				848.25	
					$790.89
	Outstanding accounts unsettled,				218.73
					$572.16

Respectfully submitted,
EDWIN DARLING, Treasurer.

Approved for Finance Committee,
GEO. E. BATCHELDER.

On motion of Mr. Coggeshall the report was received and placed on file.

REPORT OF THE FINANCE COMMITTEE.

Mr. Glover. In the absence of Mr. Batchelder, the only member of the Finance Committee who is in town, I would say that he examined the reports this morning and they bear his endorsement.

COMMITTEE TO NOMINATE OFFICERS.

Mr. Hall. I would like to introduce at this time a motion, that the President appoint a committee of three to take into consideration and report later in the session of the Association a list of officers for the following year. I offer the motion now that the committee may have ample time for consultation, and would suggest that the committee consist of three.

The motion was carried and the Chairman appointed as the committe Messrs. Hall of Quincy, Noyes of Newton and Sherman of Providence.

ELECTION OF MEMBERS.

The Secretary read the following list of names of applicants for membership in the Association, all of whom had been considered and favorably reported upon by the Executive Committee:

FOR ACTIVE MEMBERS.

Rudolph Hering, Chicago.
Frederick P. Stearns, Boston.
William E. McClintock, Chelsea.
George F. Swain, Boston.
George A. Kimball, Boston.
J. J. R. Croes, New York.
Louis H. Knapp, Buffalo, N. Y.
Arthur W. F. Brown, Fitchburg, Mass.
R. A. Jones, Spokane Falls, Wash. T.

Wilson Henderson, Peterborough, Canada.
William Molis, Muscatine, Iowa.
E. A. W. Hammatt, Boston.
R. S. Hicks, Stafford Springs, Conn.
Weaver Osborne, Fall River.
Charles H. Baldwin, Boston.
Charles E. Chandler, Norwich, Conn.
C. C. Hitchcock, Ware, Mass.
W. W. Robertson, Fall River.
S. J. Winslow, Pittsfield, N. H.
Cyrus B. Martin, Norwich, N. Y.
C. H. Truesdell, Central Falls, Conn.
W. C. Boyce, Worcester.
Melvin C. French, Kingston, Mass.
D. N. Tower, Cohasset, Mass.
Everett Burns, Westerly, R. I.
F. A. W. Davis, Indianapolis, Ind.
John C. Whitney, Newton.
John L. Harrington, Cambridge.
William Schwenk, Mount Carmel, Pa.,
Solon F. Smith. Grafton, Mass.

FOR ASSOCIATE MEMBERS.

R. A. Robertson, Jr., agent of the Builders' Iron Foundry, Providence, R. I.
Pancoast & Rogers, New York city.

On motion of Mr. Hall the Secretary was directed to cast the vote of the Association for the list as read which he did, and the Chairman declared the gentlemen whose names had been read elected members of the Association.

SOME PRACTICAL DETAILS OF WATER WORKS MANAGEMENT.

Mr. Edwin Darling, Superintendent of Water Works, Pawtucket, R. I., read the following paper.

The subject assigned to me presents a variety of heads or points of interest that might be developed to a volume of no mean dimensions, but I shall only scan them lightly, or your patience would be exhausted.

I would notice:—

1st. A system of good works.

2d. A corps of efficient workmen.

3d. A compensation to workmen that will stimulate interest in the work.

4th. The care and protection of main pipes and gates.

5th. The care and location of hydrants to make them efficient for fire service.

6th. The examination of services to see that there is no waste of water.

7th. Protection of the supply.

8th. Duties of the Superintendent, and the relation which should exist between himself and the Board of Water Commissioners.

9th. Relations of the city or town government with the Commissioners or Superintendent; and

10th. The good results which will follow when the officers of the works are properly endorsed by the city or town officials.

Among and from the systems in use, my preference would be for a gravity plan, even at greater cost than others. My next choice would be a pumping station and reservoir; then, direct pumping, or what is known as the "Holly System," but under any and all circumstances, a system of water works in every city, town or village, where pure water can be obtained.

For the past eight years it has been my fortune to have charge of a system of water works that combines, practically, all of these complications and pumping by water power, so you will pardon me if I assume to speak of any situation that could be called for in a system of water works, and shall presume that every place has a good one.

Careful consideration should be given to the proper location of the mains. The size of the mains should be considered, and should be not only adequate for the present demand, but should anticipate the wants of the future for at least a generation to come. A great mistake is made by many cities and towns in putting in manis insufficient to supply even the present demand, from a mistaken economy of expense, Now, I assume the ground that no city or town can afford to stint the supply or efficiency of its water works. It should be liberal, in the size of pipes, location of hydrants, gates, and especially so in the number of hydrants, for here comes the important part of water works. Convince the citizens of any city or town that you have a good fire protection, and the water works become popular at once. To secure such protection the mains must be of sufficient capacity to supply any demand, and the elevation of water must be such as to produce a pressure of 70 or more pounds to the square inch. The location of the pumping station, if such is required, has much to do with the efficiency of the water works, but it will be allowed that more depends on the pumping engine. Many cities and towns curtail the efficiency of their works by furnishing an engine of capacity barely equal to the present demand to save expense. True economy will put in a much larger engine that might possibly suffice for the time, for it is the universal experience of all water works that the capacity of the engine is the first to be exhausted. Here let me enforce the importance of a *good engine*, and of sufficient capacity at the beginning of the work. I could enumerate many works that are in need of larger pumping engines to-day, where it was thought they had sufficient pumping capacity for a much longer time than had passed since their works were built. Practical experience shows that water works grow in demand much faster than the most sanguine projectors anticipate and it is impossible to err when you build largely in excess of the present demand.

The employees should be men of good habits and unvarying courtesy. To illustrate—take the Water Registrar or clerk in the office, if he does not need the patience of a Job, may I ask who does? With the thousand and one questions he is asked, with the knowledge that is forced upon him by being informed how small the family is; the beautiful well

situated, perhaps, just beyond the cesspool, and the splendid large cisterns connected with the premises, making it impossible to use but very little water. All this stock of information he is expected to believe and treasure for future use in adjusting the bills, and he requires a degree of fortitude known best by those having the experience of the situation.

I think my friend, B. F. Jones, Superintendent of Kansas City, when he inserted in "Hints to Water Consumers" the following statement: "In making contracts for use of water, it is only a waste of time to state how small the family is, how large the cistern is, or what a small amount of water is required. If these details are omitted, it will be considered in making water rates that all families are small, that *every one* uses less water than any one else, and that every house has a splendid cistern," realized the situation that the registrar or clerk is placed in. This is but one case, and leaves the thousand to be met with that courtesy known only to those who hold these positions.

Again, the inspector of meters and service pipes must be a man of courteous deportment, a gentleman and a scholar, or he will meet with sudden rebuffs if he does not approach his business and subject with a great deal of caution. Most of you remember the experiences related by our friend Walker a few months ago.

The service pipe foreman and his men must be very polite and affable, for should they begin to dig in a street, generally six or eight "Sons of Rest" want to know what is to be done, and why, what for, and why it is not done some other way; how much water is to be used, what it will cost, and if it could not be done at night so as not to obstruct the sidewalk in the daytime; and every new one that comes that way must be quietly and civilly answered the same round of questions, and should some ambitious reporter happen along, he will publish the necessary instructions the next day, but too late to assist in the matter?

The corps of men at the pumping station should be first class workmen, and the engineer in charge, the responsible party, holding, as he does, the key to the situation, should have full control of all, and realize that his integrity is at stake. The best feelings should exist between the engineer and his subordinates, and each should feel that he has a duty to perform and each take a pride in performing it. A system that requires a place for everything and everything in its place, with neatness, should be established in the beginning and maintained to the end as regards everything in or about the station, and no employee should so far forget his duty as to leave undone that which has its time and place to be done. Courtesy should be extended to all visitors.

A water-works, to the business mind, is looked upon in the light of a machine shop or other mechanical works, but the practical workings are far different. While the laborer in the shop or factory finishes his labor with the expiration of ten hours, the Superintendent, the engineer and his men at the pumping station know no time for a day's work. Certain work is to be done, and it is to be performed without regard to time. The service pipe department is liable to be called at any time—by night as well as by day—thus placing those employed on a water works under different situations than men employed in mechanical pursuits, and they should

receive a compensation which will make them feel satisfied with the position, and so encourage them to perform their duties to the satisfaction not only of their employers, but to themselves and the public.

The care and protection of main pipes depends largely upon the manner in which they were first laid in the ground. If cast-iron pipe of proper weight is used, and laid at a proper depth, (which in New England should never be less than 5 ft. below the surface,) and properly caulked at the time, then but little care will be required. On the other hand if any of these requirements are neglected, the amount of labor and trouble is only measured by the circumstances of pressure, weather and chance.

Gates or valves should be examined twice or more in a year, and shut and opened and the stem oiled, if possible. Hydrants should be examined at least twice in each year to see that they are in working order. The difference in make and pattern of hydrants leads to a different mode of inspection and different seasons of the year, and is especially affected by extreme depth of frost,—for then comes a time when the Superintendent is held responsible for that which no human eye can see. To open hydrants in extreme cold weather simply to see if they are frozen, is, to say the least, dangerous and should be done with only the utmost caution. When the ground is frozen 3 or 4 ft. in depth, the frost produces results which no human mind can foresee, and there may be a chance of finding a small per cent. of the hydrants frosted.

There should be a thorough house to house inspection at least twice a year, even with a liberal supply of meters, but where the supply of meters is very limited, I would keep the inspector on the road all the time. This costs money, but prevents waste; that is to say, prevents it just about the time the inspector is there or expected, after he is gone the willful waste goes on as usual.

This opens the great question of waste of water and how to prevent it, which is being discussed not only in this section, but wherever water works have been established.

The magnitude of the question has puzzled great minds and must be left to men of science, though some suggestions may not be out of place, and make a basis for thought and inquiry that shall prove a benefit to those interested. One very gratifying fact in regard to this problem, is seen in the increased use of meters in cities where waste was assuming dimensions that demand immediate action, and that in proportion to the introduction of meters the enormous waste has, in a measure, been checked, and many as well as myself believe that here lies, at least a partial remedy. A comparison made some few years since between a few large cities as regarded consumption and revenue, showed about 60 per cent. of consumption in favor of meters, and from 200 to 300 per cent. of revenue in favor of meters. With these statistics, based on facts and figures taken from water reports, it is safe to urge the adoption of meters in all cases to stop the waste of water where the circumstances will allow, even if at first view it might not seem practical.

The supply demands careful inspection, and continual watchfulness that no contamination be permitted, for this is not only the stock in trade, but the reserve fund, and must be guarded with jealous care, and every

innovation be promptly met, even to calling on the law for protection.

The State of Massachusetts has appointed a State Board of Health, having in its charge the sanitary question, which promises grand results, and to which all Superintennents are invited to contribute information, and their aid and assistance is asked in the great work, and should be cheerfully granted.

The Superintendent should be a man whose whole mind is devoted to the work, but it does not follow that he must be able to affix C. E. to his signature, provided the services of one can be obtained at his convenience or in his need. He should be responsible for any detail in or about the works, therefore should not be expected to perform much manual labor, yet to my own knowledge, there are many in New England that do. The relations existing with the Board of Commissioners should be such as to assure him of its confidence, and that his efforts are duly appreciated. This will encourage and stimulate him to faithfulness, and enable him to perform his labors with a degree of ease and ability. He should be allowed to employ such help as is best adapted to the labor required, without any party or political prejudice, and he alone is able to judge and decide what is needed. Many cities and towns make the department a political pot, to be boiled at every election of officers.

As the water works is generally the only department that produces a revenue to the city or town, it should be conducted strictly on business principles. What corporation or manufacturing company makes radical changes of Snperintendent or employees every year at the annual election of officers when the work has been satisfactorily performed and results produced that are satisfactory to the company or corporation?

A great mistake is made by any city or town that allows politics to enter or hold rule in the Water Department. The motto in selecting the Board of Water Commissioners should be, "The best man for the place regardless of political opinion," and having so selected the board, they should be fully endorsed by the city or town government, and held strictly responsible for the department. They should have full control, and it should be their duty to manage, oversee, run, and have the sole and exclusive care of the works, make extensions of mains, or otherwise increase the efficiency of the works; provided, always, that they shall not incur at any time any debt on account of the works in excess of the appropriations which will be from time to time made therefor.

Water works conducted on the foregoing plan cannot fail to produce results which will be endorsed not only by the city or town officials, but by the citizens and tax-payers at large.

There are at the present time many water-works in New England that can be enumerated which are conducted on this plan, and when results are compared with works conducted on a faulty plan, the difference is too marked to need comment.

The Chairman. This very interesting paper by Mr. Darling is now before the Association for discussion.

Mr. Clark. I have listened to the paper which has been read with a great deal of interest and with almost unalloyed satisfaction, and I hope it

will be put in print and have as wide a circulation as possible among the water takers with whom we are connected. There is one point I would like to inquire about, rather than to criticise, and that is whether an examination of hydrants twice a year is sufficient. There are some works where the examination is made every month, and a record is kept of every examination. The parties to whom I refer believe this to be necessary for the protection of the Superintendent, in case any accident should be found to have disabled a hydrant when the fire department want to use it. I would ask whether it would not be better to have an examination made monthly rather than semi-annually. I do not suppose it is at all necessary to let on the water in cold weather, but there are ways of examining a hydrant in the winter which will satisfy us whether the hydrant is in condition to be used.

Mr. Darling. I am very glad my friend has called that subject up, as that was something I tried to get before the Association last winter, for I wanted to find out how much of an examination was made as a general thing. From what I learned then I came to the conclusion that twice a year was about as often as anybody did examine them. I think it depends somewhat upon the kind of hydrant. Certain styles of hydrants require to be examined, perhaps, oftener than the post hydrant, —for instance, those of the Lowry pattern that are practically under ground, and where the pit is liable to fill in heavy rains if it is not properly drained. I should suppose it would be necessary to examine that class of hydrants more frequently. We have made it a rule to examine ours as I have stated, and we have had very good results. On the Cumberland division, by request of the Cumberland council, they are examined every month. I would like to hear the opinion of other gentlemen on this subject, and what their experience has been.

Mr. Richards. I should think, Mr. President, it would depend somewhat on the location as well as the make of the hydrant. If a hydrant is located in springy ground or below high tide, it may require examination oftener than once a month, but if it is in a favorable location it may not require examination more than once a year. That is something that must be left to the judgment of the Superintendent. There are hydrants at New London that require examination at every cold snap.

Mr. Darling. You would recommend having all of them examined at least twice a year?

Mr. Richards. O, yes.

Mr. Darling. The impression I got at the meeting last January was that some Superintendents did not examine them at all, not even once a year; that there was never any thorough examination by them.

Mr. Gamel. Do you use salt as a protection?

Mr. Darling. I do sometimes.

The Chairman. His Honor the Mayor suggests that Superintendent Walker may have something to say on this subject that will interest us. (Applause).

Mr. Walker. I guess I had better not say anything here, I am a stranger. (Laughter.)

The Mayor. I hope the gentlemen will excuse me, but I suggested to the Chairman that the firemen undertook to try the hydrants last year,

and Mr. Walker had some little fun with them; I didn't know but what he would like to tell his experience.

Mr. Walker. The fact of it is this: We have the old Boston machine hydrant here with a leather valve, and it is impossible to drain the hydrant dry, perfectly dry, so but what there will be a little water in it. Well, last winter I was sent for by his Honor the Mayor, this gentleman right there (laughter). He had another man there, and he wanted to know how it was about the hydrants,—said he had found two frozen hydrants. I told him I didn't know but understood that was the fact, and, furthermore, they would always find them frozen if they kept trying them. I said I understood they had been around the first cold snap and opened them, and, said I, "If they open the hydrants I am not going to be responsible for them, for they will freeze sure." I explained that the idea was this: If you open the hydrant on a very cold day it won't drain right off; it will drain so slowly that there will be a little sort of a cup around this leather valve that will freeze. Now you may try it yourself any time and then go and thaw it out when you like, but if you go there the next morning you will have to thaw it out again, and you will have to keep thawing it out till it comes warm weather.

The best way to try the hydrants is to let them alone in cold weather and examine them in the fall and in the spring of the year. That is my idea. I don't want you to think I am right, for I sometimes get things wrong. (Laughter). My idea is to examine them in the fall, along in October or November before it is freezing, look at them thoroughly, and then you have got to trust to luck about their leaking. If they happen to leak a mite they will freeze, and the more you fool with them in cold weather the more work you will have for your pains. When I came here they were thawing out ten or fifteen hydrants a day, and they had the steamers out all night one night thawing them out. I went to some of you Superintendents and asked about it, and you said the best thing was to let them alone and from that time till to-day we have let them alone and have had good results. We haven't had but just two hydrants frozen for 12 years when there was a fire, although there have been some frozen because we have tried them where they have been in wet places where they were liable to freeze? We haven't had any trouble at all of any account until last winter, and it was lucky they were frozen then, because the chemical put out the fire so there wasn't any damage done by water. (Laughter).

Mr. Hall. The remarks of our friend, Mr. Walker, have suggested one very important question, and that is as to who shall have the care of the hydrants. It seems to me there is only one proper party to have charge of them, and that is the water department. Both the Mayor and Mr. Walker have given an illustration of a divided authority. I am of opinion that the Superintendent of the works is the party to be held responsible for the condition of the hydrants, both in summer and in winter. But I fail to see how he can keep them in order if individuals from other departments of the city are constantly opening and closing them without his permission or knowledge. Probably the experience of almost every Superintendent here is that application is often made for the use of the

hydrants for various purposes and on various pretexts. Sometimes the firemen are anxious to try a piece of apparatus, or the engineers are anxious to know whether a hydrant is frozen or not. My rule has always been to tell them, as Mr. Walker does, to let them alone till warm weather comes, and then they can see whether they are frozen if they want to. (Laughter.) Whenever hydrants are used in cold weather for fire purposes I always intend to have them examined immediately, or as soon as possible after use, to take care of them as well as they can be taken care of at the time, and then to let them alone.

The Chairman. At Woonsocket we have two systems of pipes, the new water works system and what is called the corporation system, which was supplied by force pumps from the different mills; and during the past year they have employed a man, under the direction of the fire department, called a supervisor of pipes and hydrants, whose duty it is to see that the hydrants are at all times ready for use. He does not interfere with the duties of the Superintendent in any way, and does not open the hydrants except with his permission; but he examines the hydrants and reports to him any that may need attention. And during the past winter in severe weather every hydrant, we use the Chapman hydrant, was examined every day, by simply turning the spindle to see if it was loose; not opening the hydrant so as to draw any water, but just trying the spindle to see if it was loose. We had no trouble last winter, but the winter before that we had a good deal of trouble.

Mr. Walker I would like to say one word more and that is all, for I will not take up much of your time. It makes a difference about trying these hydrants whether you have cement pipe which is a little mite rotten. (Laughter.) Sometimes you try a hydrant and shut it down ever so slowly, if the valve is out of order and it gives a little jerk, away goes three pieces of pipe, and that section has to be shut off on some cold night to mend it. So you see different parties are differently situated about trying hydrants. It is the last straw that breaks the camel's back, and it is a very easy thing to strip up a lot of cement pipe. When that experiment was tried last winter I recollect that there were three lengths,—it never rains with me unless is pours,—burst by opening and shutting hydrants. There is danger of shutting them too quick, or there may be a little slip in the valve. So I want you to bear in mind, when we are talking about this matter here, that we have cement pipe; and if the man from Fitchburg were here we might talk with him a little as to experience he has had with it. (Laughter.) We have got to handle that thing pretty carefully. With a good stout hydrant and good cast iron pipe there is not the danger with hydrants that we have here.

Mr. Tidd. I should like to ask the gentleman if the trouble he has had has not been with poppett valves? I never have had any trouble with gate hydrants, but I have had trouble with the others, and that comes from the absorption of the water by the disk, the leather disk; of course that will retain the water and it will be months before the water would be got out, and as long as that leather is wet it will freeze on anything it touches. Then there is another trouble he speaks of, that the disk sometimes gets loose. While the hydrant is open there is a downward pres-

sure on the disk and when you close the hydrant the pressure suddenly changes from the top to the bottom and produces the ram which he speaks of, and that will break most any pipe. I don't mean to be understood as an advocate of cement pipe (laughter); I am not at all; but I mean to say I have known it to break cast-iron pipe. I think, as Mr. Darling has suggested, that the fall and spring is the proper time to look after the hydrants, when the weather is good. But still, if the hydrants are to be put out of commission on account of the danger of freezing in winter, you never can use them for fire purposes. I prefer a gate hydrant rather than one with a poppett valve.

The Chairman. I would say in regard to hydrants freezing in case of a fire that I have found in our town in very severe weather four or five hydrants frozen after a fire so it was impossible to open them.

Mr. Tidd. Gate hydrants?

The Chairman. Gate hydrants; so that now when a hydrant is used in very severe weather we always go around afterwards and salt it.

Mr. Tidd. I don't like the idea of putting salt into anything composed of iron; the corrosive qualities of salt are rather severe. It seems to me such a thing as the President speaks of must have been caused by the bad location of the hydrant. I never have had any trouble with hydrants properly set; they should be set low enough so they wouldn't freeze.

The Chairman. I would say that at the time I speak of the frost was over five feet deep in our streets, and almost everything froze.

Mr. Darling. In that case your pipes would freeze up outside of your hydrants.

The Chairman. Not where there was a circulation; hydrant branches in some cases did freeze.

Mr. Darling. Every hydrant is a dead end, so if the frost was five feet deep the pipes would be frozen up.

The Chairman. I presume, perhaps, I should qualify that statement a little. It probably wasn't five feet deep in all places, but where I had trouble with the pipe and dug down to it, I found it in one or two instances over that depth.

Mr. Darling. That was winter before last ?

The Chairman. Yes, sir.

Mr. Darling. And that was the first winter of your works?

The Chairman. Yes, sir.

Mr. Darling. Then of course your ground was new, and frost will penetrate deeper in new dug ground than in other ground.

The Chairman. I have found that so in several instances. In digging for services in one or two cases I remember we didn't find the right place at first, we didn't hit exactly on the ditch, and we found the location of the pipe by working along until we struck the frost again.

Mr. Tidd. It seems to me, Mr. Chairman, that the greatest danger from freezing is in the branch near the hydrant. In many cases in the State of Maine where the sreet is crowned up very high, unless the pipe is placed at a great distance below the grade of the highest point of the street, the branch where it passes under the gutter is not deep enough. I have seen them where they have been covered less than three feet; and in cases like

that they are very likely to get caught, because the water in the hydrant branch must stand still, there is no circulation, and it is usually a small branch. In many towns they use a 4-inch hydrant and a 4-inch pipe, which is a little larger than a goose quill (laughter), and it freezes very quickly. My own opinion is that no hydrant should be placed on less than a 6-inch branch.

The Chairman. The hydrants I speak of were six feet below the surface of the ground, that is, from the surface to the centre of the pipe, and I never have had any trouble with those.

Mr. Billings. There are two sources from which water may come to give trouble in hydrants,—it may come from a main through a leaky valve, or from the water in the ground. The trouble with water from a leaky valve can of course be remedied by substituting a new valve or a new hydrant, and under ordinary circumstances the water in the ground can be taken care of fairly well if the town is properly sewered. But we are so unfortunate in Taunton as to have very few sewers; and I should be very glad if any one can suggest to me how I can be sure of certain hydrants which are placed in rather wet soil, where there is not a sewer within a thousand feet, and no way of getting rid of the water. Such hydrants are almost sure to freeze every winter by the surface water coming up within a foot or two of the surface and catching. If I plug the drip-valve to keep the surface water out, then I am certain to have trouble if the hydrant leaks a particle, and so I have to trust to luck, as Mr. Walker does, and shall have to continue to do so unless some one can suggest some other way.

Mr. Tidd. I don't want to take all the time, but the remarks of the gentleman have suggested something to my mind. Hydrants or pipes in wet ground, where the water stands will very seldom freeze. If the ground is full of water it rarely ever freezes more than an inch or two on the top, and most always I have found such a place as that to be safer than hard clay. In the city of Lewiston there are many places where the city is built on beds of pure brick clay, and in the streets where there were no sewers that we could connect with we built wells under the sidewalk near the hydrants. We built them below the base of the hydrant, and ran a small pipe from the hydrant into the well, and then we had a tube connecting with the surface of the ground, through which we could pump the well out. The wells are large enough to hold several charges of the hydrant, and each time after a hydrant had been used the charges would run off into the well, and we could pump the water out. So far they have been a success. They have been in now some ten years, and we never had any trouble with them so long as we pumped them out. The well must be below the hydrant and be large enough to hold five or six charges of the hydrant, for they are liable to shut off five or six times during a fire.

Mr. Richards. There is one place where Mr. Tidd's well wouldn't work, and that is where the tide rises up into the hydrant, where the hydrant is below high tide. There are numerous places along the salt water front where the tide rises higher than the pipe. I know of cases where the tide will rise up into the stand pipe of the hdyrant, and in extreme cold weather

it will freeze and you can't get any water through the hydrant as long as that ice is there.

Mr. Tidd. I never should put a hydrant in such a place as that (laughter.)

Mr. Darling. We have had gate hydrants on our works which were located in wet soil, and they bothered us so every winter that we had to take them out. The firemen would get at them once in a while, and they would come and say, "Those hydrants are frozen, and you have got to go and thaw them out." I thawed them out two or three winters, and had to keep thawing them out. It is just as Mr. Walker says, if you begin to thaw them out you have got to keep at it. The way I managed was to have a man go every day and break the little tongue of ice which would form during the night. But I finally gave that up, and last year took the drips out and plugged them up solid, and I am ready to take the chances of a leaky gate. Last winter we tried them two or three times and found they were working successfully. Whenever a hydrant is used the firemen notify us, and I send a man there to take the water out.

Mr. Noyes. In answer particularly to Mr. Billings' question I would suggest a remedy that I have found to be effective. In many cases a hydrant can be set where a sward of grass can be put around it, and that will prevent the frost going down so deep; it will prevent the frost going down around the casing of the pipe as it would if it was placed in gravelly soil or in a paved sidewalk. In some cases, where it would not be too unsightly, it may be wrapped with hay for some distance.

Mr. Billings. Mr. Noyes' remark about a frost jacket leads me to ask if any of the gentlemen here have ventured to dispense with frost jackets on hydrants. I had occasion last fall to change a hydrant which was in rather clayey soil, the frost jacket had got broken, and in putting the hydrant back I put it in without any frost jacket. I took out the clay and filled in with sand and left the hydrant that way, and I had no trouble with it this winter. I would like to know if you think it is safe to set hydrants without frost jackets in any cases or in all cases?

Mr. Darling. I have got 700, and there isn't one that has a frost jacket on it, there is nothing but a straight 6-inch pipe.

Mr. Tidd. I have had a good many set in the same way. In cases where the soil was hard, loamy or clayey and likely to lift the hydrant, I have filled the hole with loose gravel or sand, and I think in all cases they have worked well. Still, I should prefer to have a frost jacket around them, for sometimes the sand might get filled with water and freeze harder than I would like to have it at the top of the hydrant. However, as I say, I never have had any trouble with them, and I have set all of them in Hyde Park that way.

The Chairman. I would like to ask Mr. Tidd or some other gentleman what he would do when a hydrant freezes after a fire, for you know a fire is likely to break out in the same locality a second time.

Mr. Tidd. It depends on what part of the hydrant is frozen. I don't think half an inch of ice, or perhaps an inch, on the top of the water standing in the hydrant would do any harm to the hydrant; I dont think it would

be hard enough to break the hydrant. It might if it froze two inches or three inches. I remember once being called to a hydrant which had been open and could not be closed. The thermometer was six or eight below zero. We had to shut the gate, shut the hydrant off, and pump it out as Mr. Darling has suggested with a small suction pump. The next day we took the hydrant out and found a felt hat and thirty pounds of lead in it, so it couldn't work very well. (Laughter.)

Mr. Darling. A gentleman on my right asks, "How about the drip?" In clayey soil, hard pan, when we set our hydrants we put stone down at the bottom and have two feet of open space there for the drip to go into. In sandy soil, of course it will pass away readily. In clay or hard pan, where it is hard for the water to penetrate; we just rim a circuit of stone around the hydrant.

Mr. Tidd. I think there is some misapprehension here as to the reason for using a frost case or its benefit. I have no doubt that when it was first used it was used to keep frost away from the hydrant, or rather to keep it from freezing. But that, certainly, has not been the reason why we have used them lately, or within the last few years. My object in using them has been this: If the hydrant is set in clay or hard pan, anything that will freeze hard, it will close on the frost case and lift it, and if the frost case lifts, it lifts usually without disturbing the hydrant. Now, if it froze on to the hydrant it would certainly pull it off the joint and make it leak. That is what I use a frost jacket for, not to keep the frost out.

REPORT OF THE COMMITTEE ON BADGES.

The Chairman. If no other gentleman desires to speak, we will proceed to the next business. I will call for the report of the Committee on Badges.

Mr. Darling. President Rogers was the Chairman of the committee, and the committee has never been called to together. I do not know but what there was a misunderstanding, perhaps there was, but he certainly was Chairman of the committee. I would ask that the committee be continued and given further time to report.

The Chairman. If there is no objection the committee will be continued without a vote of the Association.

CLASSIFICATION OF WATER RATES.

Mr. Glover. On behalf of the Committee on Classification of Water Rates, I have to report that the Chairman of the Committee, owing to his business, which has taken him away from this section of the country a large portion of the winter, has taken it upon himself without consultation with the other members to prepare and submit a very voluminous report, and I should think it was a very valuable report. But as it covers thirty pages of type writing on legal cap paper, I would suggest that its reading be postponed until this evening, and that some other business be taken up at present.

The Chairman. If there is no objection the reading of the report will be passed. Now an opportunity will be given for the asking and answering of questions.

CONTROL AND MANAGEMENT OF SERVICE PIPES.

Mr. Walker. I should like to have some member give me advice as to what do in a case of this kind. We put a service pipe into a building and it was large enough to supply what the man supposed he would want; but, now, he takes a notion he wants to run an elevator by water power, and he comes to the water board and says he wants a three-inch pipe put in. The question arises whether the city should tap the pipe and put in a three-inch branch, and put it into the building at a cost, perhaps, in some places of $200 or more; would you put it in for him and let the city pay the expense, for about $30 to $40 a year for that elevator, or would you say, "If you want anything extra we will put in as large a pipe as you want and you shall pay whatever difference it costs, and you can have just such a meter put on as you choose, and pay for the meter and pay for the water?" What has been the practice with you Superintendents; what have you done in such a case? I haven't had much experience with motors and elevators, and hardly know what it is best to do. Every man, of course, "wants the earth" when he comes to have anything to do with the water works department. He thinks if he pays a tax, if it is not more than $30, he is entitled to anything he wants. Here is a man who has a block and you get about $100 out of him a year, and here is another man who owns quite a nice building and store and his bill is about $30 a year, and he wants a pipe three inches and sometimes four, and he thinks the city ought to give it to him because he pays a big tax. So we have that difficulty to contend against. They don't see why you can't do it for them under certain circumstances, why you can't alter the rule under certain circumstances. Now, if somebody will give me the information I want here publicly, it will save me asking each one of you privately, for I have been requested to make the inquiry. There are, perhaps, three parties in this city who want to put in hydraulic elevators and who want us to put in the pipe for them.

Mr. Coggeshall. I would say in answer to Brother Walker's question that our practice has been in every such case to charge the whole expense, including the meter, to the party desiring the motive power.

Mr. Richards. I do not see why you should charge for a three-inch service pipe any more than you should charge for a half-inch service pipe, providing you get a water rent in proportion to the quantity of water used and the cost of the service pipe. I think you should reckon the rent according to the size of the pipe somewhat, as well as the amount of water used. If you had a minimum rate for a certain size pipe that would be the easiest way out of it, and then let the pipe; because you ought to furnish pipe of one size as well as another, and you also ought to control the pipe and own it.

Mr. Walker. We have already furnished him with one pipe which was sufficient, and now he wants this other extra.

Mr. Richards. It is not sufficient for his motor?

Mr. Walker. No.

Mr. Coggeshall. I would say that, perhaps, we are a little differently situated than any other water works in the United States. We give the water away down there, so we get hardly any revenue from it.

Mr. Darling. We have a rule for such a case as Brother Walker presents. We furnish an inch service for everybody. We don't put in anything less than that even for a small family. When we put in anything larger than an inch we charge the difference in the cost of putting it in. When an estate has had its inch service put in, if an additional service is wanted for motors, elevators or anything else, the whole cost is charged. The party has got to pay for the cutting out of the old pipe, he has got to pay for the T and the pipe and the service clear into the building, for he has already got an inch service. And I believe that is the way it should be. I don't believe it should be according to the quantity of water at all. I think every man should have a service, and one man as big as another; and then, if any man wants anything different, he pays for it. Because, when he gets his water, the man who buys a large quantity of water is going to buy it for a good deal less in proportion than the man who buys a small quantity, with our rate.

Mr. Richards. I would not put in a larger service than was needed. I would find out what was necessary and furnish that; I wouldn't give a man a three-inch service just because he asked for it.

Mr. Darling. You will find they will all ask for it if you give it to one.

Mr. Richards. I know they often ask for a four-inch service for a dwelling-house, but they do not require it and they do not get it.

Mr. Billings. That reminds me of a gentleman in Taunton who came to the water works office when the works were first started, and said with great seriousness that he had been thinking the matter over and had decided he would have the water put into his house; and after a good deal of study as to what kind of pipe he should have he had concluded that he would have a four-inch Akron pipe. (Laughter.) It seems to me, speaking now seriously, that Mr. Darling in his remarks got a little away from the question put by Mr. Walker, which assumed that the party has a service which is sufficient. But now a man comes forward and offers to take a larger quantity of water for a special use and it is assumed to start with that he does need a larger pipe, say three inches. Is there no good reason for giving him the additional service without his paying for it? I can say that the custom in Taunton has been in the main, up to this time, substantially as Mr. Darling outlines it,—that is, if a man wanted a larger service he has paid for it. But we have been finding ourselves coming to be a little more liberal in that respect and looking at it in this way: If a man wants a three-inch service for an elevator or a motor, which, perhaps, will cost $150, if we get $30 a year water rate,—and that is a small rate for a three-inch service,—we will get a return of 20 per cent. on our investment; and most anybody would be glad to invest money at that rate. And it certainly cannot be a losing game for the city to invest money in that way, or for the water department. So that looked at as a business investment it is not so bad a thing. You may reply you do not want to go into investments and do that kind of business; but there is certainly good reason for doing this if you choose to take it up as an investment.

Mr. Baldwin. I can from experience in the Boston department tell the gentleman just exactly the ground they have taken on this subject. It is this: in case a pipe is put in for an elevator or for fire purposes, the

owner of the building shall pay the entire expense of putting in the pipe. The position they take is, that although the water rate from that pipe may pay a good interest on the outlay, still there is no guarantee that the pipe may not, within six months from the time it is put in, be discontinued by the parties it was put in for, and cease to be productive after that. In the case of service pipe they put in a pipe which will give the building a reasonable flow of water sufficient for all ordinary purposes of the building, and if the building is occupied for some purpose in which a good deal of water is required at some particular time, the man who owns the premises must put a tank on the premises and store the water so as to be able to use it as he wants it. They claim they are not bound to put in pipe that will give a man a large flow of water for five minutes at a time, if he does not use it for the rest of the day, but that he must furnish these special facilitates for his own benefit.

Mr. Winslow: I don't know as I can help Mr. Walker out much in deciding the question who should pay for the pipes, but I will say that in my town we allow an inch pipe, lined with cement to three-quarters, and a half-inch tap on the main. We put in the pipe from the main to the street line of the sidewalk, the cock and service box, at the city's expense, and from the street line to the cellar it is at the owner's expense. If the owner wants a pipe larger than what we call the service pipe, he pays the whole expense. We go on the same theory that has been spoken of here that a larger service pipe, as for a motor or for an elevator,—we haven't got any elevators, but we have had a few motors,—would be a good investment providing the motor were to be used right along. But the trouble is they will be used for a little while, and then it will be found that it is costing too much money to run them and they will be discontinued. We have had two cases of that kind; and the consequence is that we have decided to charge the whole cost for anything larger than the ordinary service.

Mr. Tidd. I suppose the idea of building water works, the main idea, is for domestic purposes. For fire purposes the water is supplied through large mains in the streets to the hydrants, and for domestic purposes through service pipes which are sufficiently large to supply it for such ordinary purposes. If any gentleman has any special purpose of his own for which he wants to use a larger supply, it seems to me he ought to pay for it. It does not seem to me proper that one man should be allowed a a service which will give him four or five times the ordinary supply, in order to help him out in some financial arrangement of his own. So in all cases where I have had that thing to do,—I have been connected with some sixteen or eighteen works,—it has been the custom to charge for all the service pipe larger than an ordinary supply, say a three-quarter inch pipe. I remember one case where a man wanted a larger supply for sprinklers in his factory, because by doing so he could effect a large saving in insurance, and, of course, that would inure to his benefit. He had declined to have a service pipe put in in the first place, but after the pipes had been carried by his place the insurance people pressed him, and he came and wanted a four-inch pipe put in. We put it in and charged him the expense, and he paid it without any complaint. He thought it was the proper thing to do, and it was. As I said before, the service pipe is

for a domestic supply, and it seems to me that for anything beyond that the party ought to pay.

Mr. Darling. There is another point. Some water works charge for the whole service pipe from the main.

Mr. Tidd. Companies.

Mr. Darling. Well, companies, I will say; and we have a representative of such companies here. In some cities and towns they charge for the whole. I think in the town where the Chairman lives, in the beginning, the company that owned the works, charged for the whole. If you wanted a service, no matter how big or how small it was, you had to pay for it. And there are some cities and towns, a gentleman reminds me, where they will only tap the main, and then you must take the water from the tap. There are some that carry it to the curbstone and then you must take it. There are works in the West where they deliver the water to the street line, and from the street line into the premises, wherever they go, the owners have to pay the whole bill. I believe you want to make a rule that there shall be a certain size service, and that the party shall pay for anything above that; and when you have put in one service, if he wants another for the same estate, he should pay for the whole of it. I have had lots of just such cases, and the parties have paid without a murmur; but if I were to break over the rule for one he would tell everybody of it, and then I would have to break it for all. The pipe is supposed to belong to the city, so far as the street line is concerned, whether they pay for it or not. It is presumed the city owns the pipe so you can shut off the stop-cock. There are some places where they have to dig down to the main when they want to shut off. In Worcester they don't have any stop-cocks and if they want to shut a man's water off they have got to go out into the street and dig down; and it is suggested to me that it is so in Boston.

Mr. Baldwin. Not now.

The Chairman. Mr. Darling's statement in regard to Woonsocket is correct as the works were run under the private company. At the present time the town furnishes a five-eighths lead service to and including the stopcock at the curb. Parties using anything larger than that must pay for it themselves.

On motion of Mr. Darling the Convention adjourned to 7.30 P. M.

WEDNESDAY EVENING SESSION.

The Convention was called to order at 7.40, Vice President Kent in the chair.

REPORT OF COMMITTEE ON EXCHANGE OF SKETCHES.

June 15th, 1887.

To the Members of the N. E. W. W. Asssociation.

Gentlemen:—At the last annual meeting of this Association, the report of this committee was accepted and placed on file, but its duties continued for another year. As stated in that report, in answer to circular letters sent out to members, there were received rough sketches of general plans of 23 water works represented in the Association. Having this data on hand, though crude in many particulars, it was decided to put the same

into available shape for the benefit of the members. This has been accomplished by the committe without cost to the Association. From these rough sketches,—revised, reduced to uniform size of 10x15 inches,—a set of tracings has been made, and a sample folio of blue prints prepared. This folio and set of tracings are herewith presented as forming the main part of this report.

The committee have information that the Mass. Institute of Technology, Boston, will, if desired, furnish prints from these tracings or any others of equal size, for the sum of five cents each, not including postage,—and it is here suggested that the Secretary make arrangements to that effect, providing he receives a suitable number of subscriptions for the same.

In conclusion your committee would say, that having earnestly striven to bring about a general exchange of sketches which if participated in by a majority of the members would be of great value to all, and having met with insufficient encouragement to warrant the hope that such a general exchange would ever take place, we respectfully recommend that the scheme of exchange be abandoned and your committee be discharged.

Respectfully submitted,

WM. B. SHERMAN,
W. H. RICHARDS.

Mr. Sherman. Of course, Mr. Chairman, when this report was written, I must say by way of explanation, I knew nothing of what would be the result of the exchange of sketches at this meeting, and, perhaps, I ought to make a word of explanation regarding the last paragraph of the report. After the scheme of exchange of sketches was presented to this Association the Conn. Association of Civil Engineers took the subject up, thinking it a good thing, and tried to get their members to exchange sketches on the same plan that was presented to us. At the last meeting of the Connecticut Association my colleague on the committee received one sketch in exchange for his, and he felt so blue—I didn't blame him, for I felt the same way myself,—that we thought it best to add that last paragraph to the report. But we do earnestly hope that we shall be gratified and surprised upon receiving at this meeting an additional number over and above what we have heretofore received. We wish every member to look carefully over the sample folio of blues which we submit and see how valuable a folio it could be made if every one of us would contribute to it. We present this set of drawings to the Association to become its property for whatever may be done with it, as suggested in the report.

The Chairman. For my own part I sincerely hope the recommendations of the committee will not be adopted.

Mr. Darling. I move that the recommendations of the committee be stricken from the report.

The Chairman. I infer from Mr. Sherman's remarks that he himself is rather in favor, now, of removing that portion of the report.

Mr. Sherman. Not exactly, Mr. Chairman. I can tell better after seeing the results of this meeting. This scheme has been before the Association, I think, between three and four years. We haven't gained any on it the last year or two. Now, if we don't gain on it this year I think it would be

right to leave the report just as it is. Before the annual meeting last year there were 68 active members; I think there were 10 or 12 received at the last annual meeting, and that would bring it up to 80. To-day we have taken in 30 active members; that makes 110. Now, we ought to get 110 sketches in exchange.

The Chairman. Perhaps it would be well to receive the report and postpone action upon the recommendations till later in the session.

Mr. Billings. Mr. Chairman, I for one cannot see this handsome piece of work that lies before me, this folio presented by the committee, without expressing my gratitude and admiration. I can see of how much benefit it may be to the members of the Association as it stands and as it may be reproduced in one form or another. I do not want the committee discharged just yet, but I hardly know in what form to make a motion. I would suggest that the sketches that members have brought to this meeting now be given into the hands of our committee, so they may see what has been done this year. Perhaps they will feel so encouraged then they will want to amend their report.

Mr. Darling. I hope we shall strike from the report the recommendations, as I have moved, but I also hope we shall continue the good work. Perhaps it will be as well to receive the report and discharge the committee. I don't believe when the Superintendents see what the committee has given us, after this folio has been passed around to-night and to-morrow and examined, that there is a single one of them who will not make up his mind to endeavor to produce a blue print for next year. It is a very easy thing; there is nothing hard about it; it is just as simple as can be. And I hope that next year we shall have a full book. Let just as many as possibly can try it. Here is a sample set so we can all see what is wanted. I don't believe but what if it is continued another year we shall be able to produce at least seventy-five. I have brought a roll to distribute among you this year; it is not as good as many of you can make, but it will answer better than none, a good deal. I hope the motion will prevail, and then if Brother Billings wishes to move that the report be received and the committee discharged, and allow it to remain that way, I think that the Superintendents, after they see this sample folio and examine it a little, will give us seventy-five next year.

Mr. Billings. I sympathize entirely with the spirit of Mr. Darling's motion, but it has occurred to me that we cannot pass any such motion. The report has come from the committee and stands as the expression of their present opinion. The meeting has no right to strike out anything from that report. The report can be recommitted to the committee with the request that they amend it, and they may do so if they see fit. I should be very glad to have them do it; but I certainly feel, and I think the gentlemen will agree with me if they think of it a moment, that we cannot alter the report. It is not our report; it is the committee's report and cannot be changed by us. I think the motion will have to be withdrawn.

Mr. Hall. I speak as one of the members of the Association who has not presented any print at this meeting, but I hope to be able to prepare one before the next annual meeting. I am not surprised at the language

of the report, but I am sorry to hear it. The blue print scheme I look upon as one of the valuable features of this Association and, while I appreciate the efforts of our committee and do not wonder they are discouraged,—the only wonder is they were not discouraged long before,—I do hope they can be induced to continue the work a little longer. If, as Mr. Sherman has stated, we have even held our own, I think it is doing well for a beginning and that it is really encouraging. I think Mr. Sherman is looking at the matter from the standpoint of what ought to be rather than from that which actually is. I wish the report might be recommitted to the committee to see if they cannot revise it, especially that portion in which they request to be discharged. It seems to me, Mr. Chairman, that we cannot afford to discharge this committee. Their duties are arduous and they at present, perhaps, see no reward for their labors, but I think I can. I think the prints which will be presented here to-night, even if the numbers may not be so large as was anticipated by the committee, will be in quality equal to and, perhaps, in advance of what we have had before. I hope before this matter is disposed of there will be a way arranged by which the scheme may be continued, at least for another year.

Mr. Stacey. I sincerely hope this committee will not be discharged. I think, perhaps, it is asking a good deal of them to work on such an uphill job, but they have shown considerable grit so far; and they have made one convert this year for I confess to having made an attempt, perhaps, crude, but still I have made a start. I looked at it in this way, that it was rather ungrateful and selfish on my part to come here and accept the sketches of other gentlemen and reap a benefit from them without giving something in return. I came very near slipping up by putting it off; as we do a good many things, till it got to be almost too late; and I am sorry to say that I had to stay home from church one bright Sunday and work the thing up. (Laughter.) If I continue in the water works business I will have some kind of a blue print here next year, if it doesn't storm all the time. (Laughter and applause.) I appreciate the work the committee has done, and, as Mr. Hall says, it is not to be wondered at that they have been discouraged. But they have shown their grit heretofore in doing what they have done, and I hope they will be continued, for they have shown they have the "sand" to carry the thing through And before their "sand" all runs out I think we ought to come to their assistance and back them up, and show that we appreciate the efforts they have made in behalf of one of the very best features of the Association. I hope they will not be discharged, but that the report will be recommitted to them with the request that the last clause be stricken out; and that we shall then take it to heart that while we are receiving so much benefit from others we ought to do a little something in return. (Applause.)

Mr. Darling. By consent of the convention I now withdraw my motion and move that the report be recommitted to the committee for their further action. Adopted.

THE WATER TANK AT FALL RIVER, MASS.

The following paper by Patrick Kieran, Supt., was read by the Junior Editor.

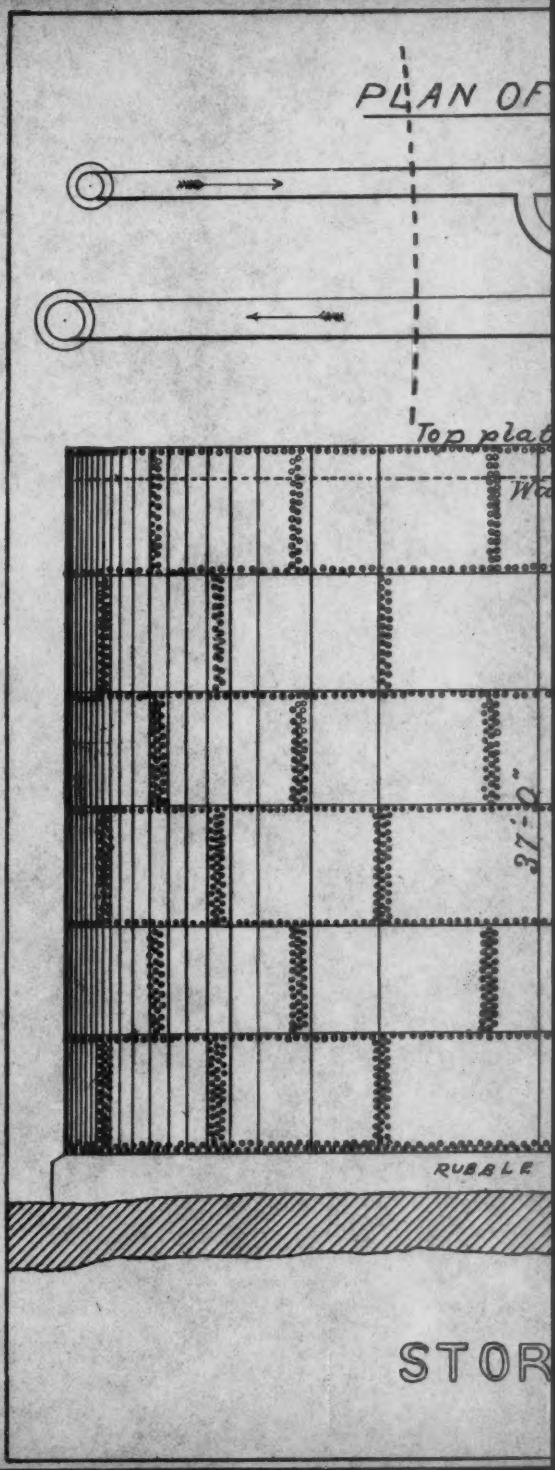
The City of Fall River has adopted the system of water tanks for a reserve supply because of the economy in cost of construction as compared with a reservoir, the building of which latter at present would be impracticable in view of the city's financial condition. The two chief reasons for constructing the tank now in use were the necessity for having a quantity of water instantly at hand in case of accidents to the engines or the force mains, and the saving in the expense of running the pumps.

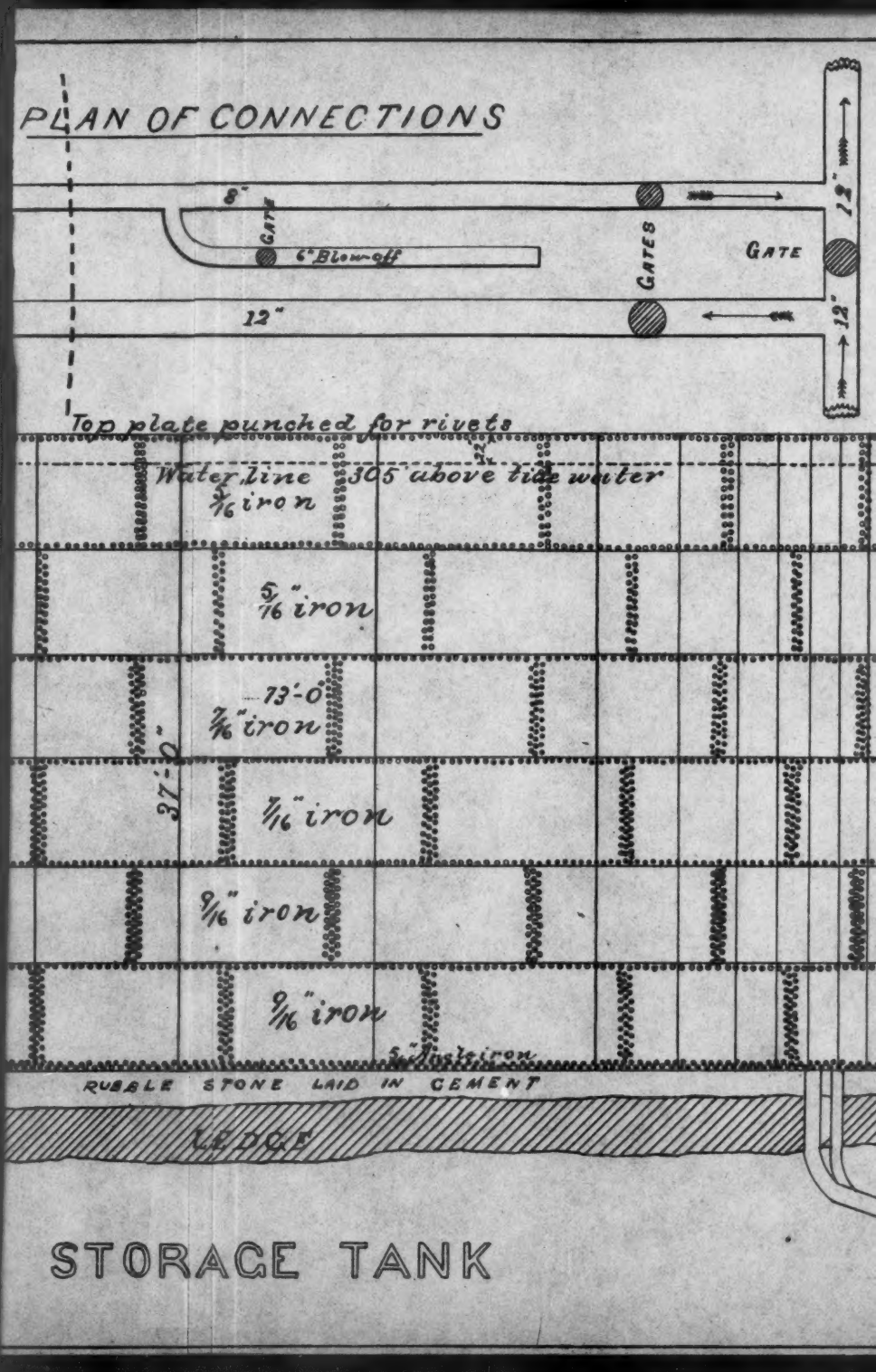
The advantages of the tank may be summed up as follows: A great saving in fuel can be made, as one pump only is now run while formerly the work of two pumps was required at certain periods of the day. Steam had to be kept on the spare pumps and steam pipes, which of course is now dispensed with. A year ago 268 gallons were pumped with one pound of coal, and at present the result is 330 gallons per pound of coal. The single pump is run at increased speed, and is thus much more economical and gives a better duty. Before this the fires had to be kept in readiness although two pumps were running daily and not performing the work which the consumption of fuel warranted. The pump is now shut down six to eight hours nightly, as the tank supply is ready to meet any emergency, as in case of a fire. Economy in running the pumps and a supply in time of accidents are the outcomes of having a tank. Following are details of the construction:

The tank is circular in shape, 73 feet in diameter and 37 feet in height. Its capacity is 1,161,448 gallons. The bottom is of $\frac{1}{2}$ inch iron; the edge being surrounded by angle iron $\frac{5}{8}$ inch in thickness, and $4\frac{1}{2}$ by $4\frac{1}{2}$ inches. The first course of twelve feet of the upright portion is of $\frac{9}{16}$ inch iron; the next twelve feet of $\frac{7}{16}$ inch iron, and the third course, thirteen feet, of $\frac{5}{16}$ inch iron. All the iron is best refined, with a tensile strength of 45,000 pounds. All the vertical seams in the first two courses of twelve feet each are triple riveted; vertical seams on third course of thirteen feet are double riveted. All rivets are of best iron, $\frac{3}{4}$ inch in diameter. A rim of angle iron, $\frac{1}{2}$ inch thick, extends around the top of tank on the inside. There is a manhole in the side of the tank, 16 by 24 inches.

An iron ladder is on both inside and outside, extending on the inside from the top to the bottom, and on the outside to within fifteen feet of the bottom of the tank. The tank is painted with three coats of best asphalt paint on the inside, and three coats best mineral paint on the outside. Connections are made with the twelve inch main in the street by one twelve inch and one eight inch pipe.

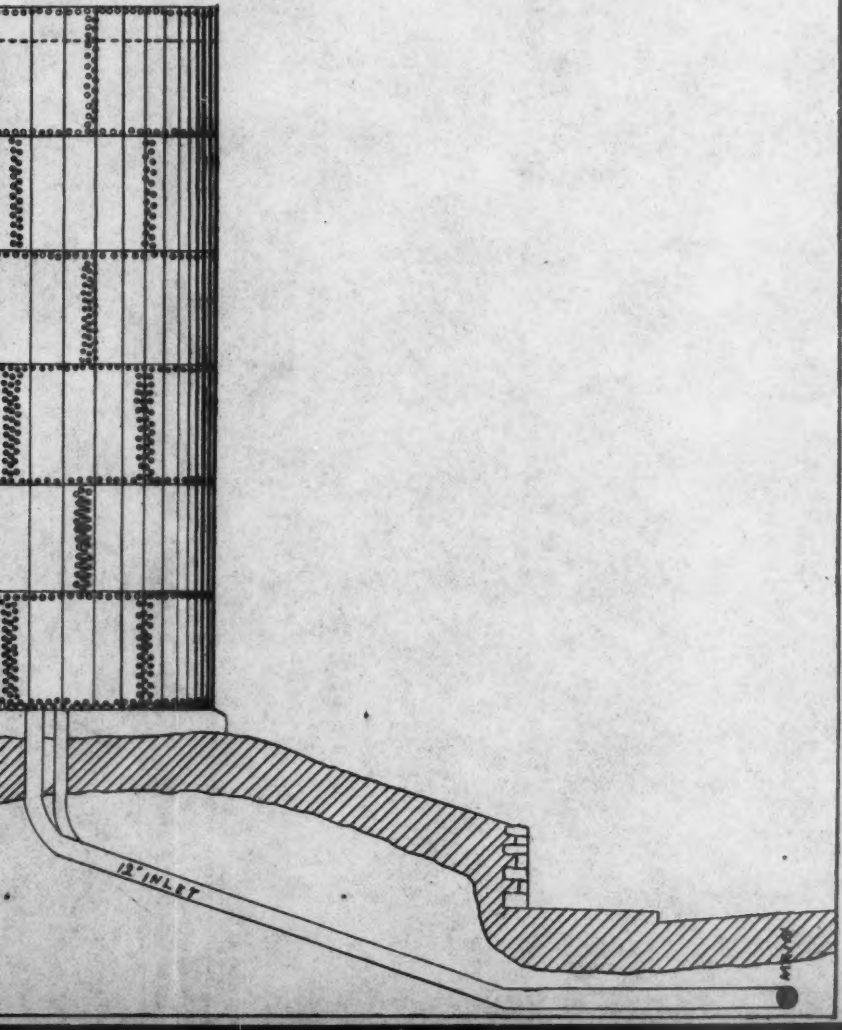
The tank was erected in the following manner: A solid foundation of stone masonry was laid, 75 feet in diameter, so as to project one foot beyond the circumference of the tank. The bottom sheets were then first laid on blocking 32 inches high to enable men to work beneath in riveting the sheets together. The bottom of the tank was surrounded by angle iron to which a first course of sheets six feet high was riveted. Water to a depth of three feet was then turned on to test the bottom. After drawing off the water, this portion of the tank by use of jack-screws was lowered into position. The centre blocking was removed first, and the bottom of the tank with its six feet of upright sheets all around was lowered into a bed of tar concrete 2 inches thick. The other sheets of the upright portion of


PLAN OF
Top plat
Wa
27'-0"
RUBBLE
STOR


PLAN OF CONNECTIONS
8"
GATE
6" Blow-off
12"
GATES
GATE
12"
12"
Top plate punched for rivets
Water Line 305 above tide water
5/16 iron
5/16" iron
73'-0"
7/16" iron
37'-0"
7/16" iron
9/16" iron
9/16" iron
5" Angle iron
RUBBLE STONE LAID IN CEMENT
LEDGE
STORAGE TANK

FALL RIVER WATER WORKS

PATRICK KIERAN SUP'T.



the tank were then hoisted into their places by blocks and falls, and bolted first and then riveted together.

The cost of the tank is thus summarized: Land for site, $1,118.80. Foundation, $1,127.90. Tank contract (awarded to Cunningham Iron Works Co.; of Charlestown, Mass.) $12,100. Bank wall, grading, etc., $650.31. Total, $14,997.01.

The Chairman. The paper is now before you for discussion. The subject is an exceedingly important one, and I hope it will be fully considered.

Mr. Tidd. Were the bottom seams caulked before the bottom was placed in position?

Mr. Billings. I cannot answer the question. Mr. Kieran simply handed the paper to me to read for him, and there is nothing said in the paper about it.

Mr. Tidd. It doesn't say whether it was tight after lowering. I should expect if they were caulked tight before lowering that the lowering would have started every joint, the bottom is always sprung more or less in the process of lowering. I have had a number of tanks built and have two building now, and I have found that if the seams are caulked before the bottom is lowered into place, the movement in lowering is almost sure to start those seams so that they will leak.

The Chairman. As I understood the paper the floor of the tank was on blocking 32 inches above the foundation. Probably after the first six feet was built on, it could be lowered by aid of jacks two inches at a time, so that the cockle would be quite slight.

Mr. Tidd. The difficulty we had was in the last two or three inches when the men couldn't get in under it. If the seams are driven up tight the change of the relation of one sheet to another will almost inevitably start the seams and make them leak. I won't say it is impossible to prevent it, but it seems so to me. I had no idea of trying the two I now have building before lowering them, for I felt confident the movement afterward would start them. Of course, the sheets are rolled as near a circle as they can be, but in all heavy iron work it is impossible to get the edges to an arc of a circle. The curve may be proper in the centre, but near the edge, very close to it, where the riveting comes they are almost always a little straighter. Now, when the tank is empty the circle is not perfect; there will be more or less flat places, comparatively flat, I mean; and when the tank is driven up in position, I have found that when the pressure comes on it from the water it will be thrown out and almost inevitably leak and have to be caulked afterwards. I have had them leak in twenty or thirty places, but after caulking they would remain all right.

The Chairman. You don't refer to caulking on the bottom?

Mr. Tidd. Yes, I refer to that. The dropping of the bottom would have even a worse effect. If the little change in form which the sheets take under the pressure will produce a leak, this change in the bottom would create more of a leak.

The Chairman. I think the paper stated that the foundation prepared was of tar and concrete. Might not that have been soft enough to have allowed the whole surface, 73 feet in diameter, to have come down so that if there

was any disturbance in lowering, the only change would be in the accomodation of the bottom to the foundation; and wouldn't the bottom be soft enough to allow the heads of the rivets to sink into that material, and thus a full and even bearing be secured. If that had been an ordinary brick foundation it would have rested on the heads of the rivets, and the sheets, which might have been four feet wide and eight or ten feet long, being thus supported at points about four feet apart in one direction and ten feet apart in another, might then settle down and disturb the caulking.

Mr. Tidd. That would not overcome my objection at all, because the edges of the plates are all planed to bring them to what we call a caulking edge. Now, to illustrate it, perhaps, in an extravagrant degree to make it apparent, suppose the edges of the sheets should break down so much that the two would not be parallel and the edges should be caulked so that they were parallel and driven up sharp. Now, the moment you move the support the turning up of the edges will turn the caulking back on the edge, and then when it comes down on the foundation, whether it be hard or soft, that caulking will be thrown up and it will leak.

We always endeavor to put them in with a soft foundation if we can, and that is one of the most difficult problems connected with the thing,—to get the bottom down into the cement. The difficulty always is to get the tank down on the cement so as to get it bedded before the cement sets. I have usually calculated to have from two to four inches of cement watered; but in the case of one or both of those I am now building I propose to mix the cement dry, and put in from two to three inches, and trust to the water I shall get through the bottom to soften it, because in that way I will be sure that the rivet heads will be bedded. In dropping down, when you get down to within two or three inches of the cement you have got to remove all your inside lining, for if you do not you will tear your cement all to pieces. And when it gets down so a man can't get in under it, you can't get anything out, and so you have got to take everything out and hang the great weight of the bottom on the edges. It will inevitably bend, and when it comes down on to the bed, however soft it may be, and returns to its former place, the caulking will turn up and it will leak.

Mr. Parker. I had experience in building a tank 30 feet in diameter quite a number of years ago. We lowered the bottom by hydraulic jacks into a bed of cement concrete, about two or three inches in thickness. Of course the rivets sunk into the soft mortar, and the iron was all covered by the cement. Then after the tank was erected, we painted it inside with three coats of asphalt varnish. If that tank did leak, if the caulking was disturbed by lowering it into position on this foundation, there is no way of ever knowing it, for the cement underneath had set hard and there was no chance for the water to come out. There was a perfectly solid stone foundation, and I don't see why there should be any trouble from leakage. The cement covers the iron and the paint inside covers the joints. We did not have any appearance of water on the outside of the tank after it was lowered.

Mr. Tidd. I would like to inquire whether the tank was not caulked after it was set down on the bed?

Mr. Parker. No, sir, it was not.

Mr. Tidd. I have tried some experiments in that line, and I have found that three coats of asphalt varnish and the cement which I have lowered the tank into did not prevent water coming through. If there is a leak in the iron joint the water will make its appearance on the outside between the iron and the cement.

Mr. Billings. I am happy to be able to give notice that Mr. Tidd or any other gentleman will now have an opportunity to get an answer to any question he may desire to ask concerning the tank which is described in Mr. Kieran's paper, by turning to Mr. Hawes of Fall River who has just arrived.

Mr. Hawes. I am not prepared to say much about this tank, Mr. Kieran will be here to-morrow, and I suppose he will be the man to give information about it,—but if anyone will ask me any question I will tell him all I know, and some things I don't know, and if he doesn't know the difference it will be all the same. (Laughter.)

Mr. Tidd. There has been a discussion here in regard to a tank which had been caulked while it was on supports thirty inches high, and caulked tight before it was lowered: the question I asked was whether in lowering the tank afterwards there was not movement enough in the bottom to produce leaks, even though it were caulked tight before it was lowered; whether in this case there were not leaks produced by the movement of the plates on each other.

Mr. Hawes. Our tank is 73 feet in diameter. We caulked up the first line of sheets, and then put in about a foot of water before we lowered it. Seven thousand rivets had been driven then, and there were only seven rivets which had to be removed. We thought we would caulk them up, but they preferred to remove them, and then we tried it with water again and there was no leak. We then lowered it into a concrete foundation three to four inches thick. And, by the way, I will say that our tank was placed on a solid rock foundation. We had to chip off a little of the rock to make it smooth and level, and then we covered it with a concrete of gravel and tar, or sand and tar, and lowered the bottom into it. If it leaked after we lowered it we never found it out. Either the concrete itself was water tight or else the tank didn't leak. We never had any leak from what we considered the bottom. Of course, there were a few little leaks around the sides which were caulked, and there were a few small ones which took themselves up in the course of two or three weeks. I do not think there is a leak in the tank to-day. As to the benefit of the tank, I will say we have seen great results in the steady pressure we get. Only last Saturday night we had quite a fire, a good many bales of cotton in a storehouse, and, as you know, it is a long tedious job to put out a fire in cotton; it isn't out yet. For several hours we pumped 120,000 gallons an hour, and the pressure was so steady that it called forth the admiration of the fire department and of the citizens who were present and now they all say we need another tank, something we have been trying to convince them of for some time. I think we will get it now. The tank has relieved our stand-pipe very much. Before, when we had a large fire and they were drawing a good deal of water, it

pulled pretty heavily on the stand-pipe, for the steamers took the water as fast as we could pump it, or did pump, it and it made a good deal of jumping in the standpipe, but it is as quiet now as you would desire it. The tank, though about two miles away, acts as a cushion and stops all the hammer we had before.

Mr. Stacy. I should like to ask the gentlemen who have had experience in lowering tanks if a good job could not be done by erecting an A truss or a double A truss with four legs, the legs taking a bearing under the jack screws, and then bringing a strain on a ring-bolt in the centre of the tank, and then lowering it into place.

Mr. Tidd. We did that very thing at Strawberry Hill,—held the centre up with an A truss,—but it sagged all around it. We raised the tank about thirty inches with the first row of plates in it, and put the mortar in as quick as we could and then lowered the tank as quick as we could It took us between an hour and a half and two hours to do it, and in that time the cement had got somewhat set, but not so, I suppose, but what the rivets set themselves in it. The A truss did hold up the centre but it sagged all around it. The diameter was forty feet and it gave some leeway.

Mr. Hawes. I think there is a good deal more fright than danger in regard to lowering the bottom of the tank. One boiler maker refused to figure on our tank, and said it couldn't be done any way. I said it could be done. He wanted to know how; I said it wasn't my business to tell him, —if I had got it to do I would do it, but I wouldn't tell him how. (Laughter.) In fact I did not know how it was going to be done, but when I saw them sawing up a lot of timber into little short pieces it dawned upon me. I consider that the sag was no more than the natural sag of the iron, and it could sag that without starting any rivets. They took out the blocking till it got down within eight or nine inches, and than they took it all out of the centre, and with their screws lowered it down to four inches; and then they put the sticks under endwise and when it got down to within two inches they knocked them out with sledges. They put the bottom in position, I think, in two hours and a half.

Mr. Darling. Was the contract for the tank made since last winter?

Hr. Hawes. The contract was made a year ago last April, and the tank was done in September.

The Chairman. I should like to ask some gentleman who is familiar with tanks to tell me as to the usual arrangement of the overflow pipe.

Mr. Tidd. The overflow I have had has generally been over the top, and I think that is a pretty common thing. An overflow pipe is something which is liable to get filled up with ice. They are sometimes made on the inside with an opening in the bottom, and the water runs into the top and down through the pipe; but in most all cases the ice pulls them out.

The Chairman. I asked the question because we had a similar experience in Woonsocket. We have a small tank there, about 50 feet in diameter and 30 feet high. The overflow pipe was arranged on the inside, and it was completely destroyed the first ice we had. I cut a hole through the top of the tank immediately below the angle iron and put on a piece of pipe about three feet long.

Mr. Hawes. Was the tank covered?

The Chairman. No, sir.

Mr. Tidd. It is a very good way to let them run over the top when you can't help it, but we don't let them when we can help it. They will generally relieve themselves that way.

The Chairman. Mr. Kieran spoke in his paper of a ladder being on the inside of his tank; I didn't know but that might share a like fate.

Mr. Tidd. In Weymouth we have a high service tank to supply South Weymouth. The other three villages are supplied by gravity, but the tank is so arranged that it can be connected with the low service by opening a gate at either of two points and give 112 feet more head, making some 250 feet in all. We got started late in the fall and there were not many services the first winter, so fearing there would not be demand enough on the high service, I instructed the engineer to connect the tank with the low service and whenever the thermometer was down to zero to pump a little at night and the first thing in the morning. He succeeded in keeping it open until one night he thought it wasn't cold enough and neglected it. He found the tank was frozen, and he finally got it started by starting up suddenly and throwing the plug out of the top. Last winter, however, the pipe was the weakest and gave way.

A member. What is the best kind of paint to use on the inside of a tank?

Mr. Tidd. Asphalt varnish is the best. It should be put on warm. You do not want to heat it enough to get it on fire, but just warm enough so it will take the iron. I think it is used almost entirely. I have used it on all the tanks I have had anything to do with, and I shall use it on the two I am building now. How long it will last is a matter of experiment, and tanks are new things. I think they should be painted once in three or four years.

Mr. Parker. The tank I spoke of is surrounded with a building. It is a circular building, with an eight-inch brick wall, a four-inch air space, and a four-inch brick wall, with two feet between that and the tank. The roof is double boarded, inside the rafters and without, and covered with tarred paper and slate. We have a formation of ice, perhaps, four inches thick over the top of the tank, which moves up and down with the water but does not catch on the sides. We do not keep any fire in the building, and run through the winter without any trouble, except that the ice forms on top.

Mr. Tidd. I know of an open tank in Houlton, Me., which was run successfully through six winters. Of course, the ice piles up in a tank that is exposed to cold weather, but it does not stick to the sides and form a solid mass. As you have seen the ice in the harbor, it crusts on the sides in large masses, but as the water rises and falls the ice breaks up and turns over and freezes in large masses sometimes three or four feet in diameter. I have sometimes seen the ice sticking over the top of the tank. I don't think I ever knew of a case of the ice freezing across the top so as to stick and cause trouble.

Mr. Hawes. I am informed they have a tank in Auburn, Me., and that they never have had any trouble from its freezing. I don't believe it it is

necessary to wall a tank in and cover it over to keep out the weather. The movement of the water up and down is sufficient to keep the ice from forming on the sides of the tank and freezing solid. We never have had any trouble at all, and we have been down to look at it when the thermometer was below zero.

Mr. Parker. There is quite a difference between zero and 35 degrees below. If any of you gentlemen want to fool with open tanks when the thermometer is 35 below zero I am perfectly willing you should, but I don't want to. (Laughter.)

Mr. Fuller. I would inquire if any gentleman knows anything about lined tanks. Some of the tanks are lined, and I would like to know what the effect of lining with cement and brick work is. I think the tank at Southborough is made that way.

Mr. Tidd. It was and it didn't work very well; the lining cracked and the water got behind it. The water is pumped from a well and comes in warmer, and I don't think the tank ever froze over.

CLASSIFICATION OF WATER RATES.

The report of the committe on classification of water rates was read by Mr. Glover.

REPORT OF SPECIAL COMMITTEE

ON THE SUBJECT OF

"UNIFORM CLASSIFICATION OF WATER RATES,"

By A. H. Howland, Chairman.

Your committe, to whom the above subject was assigned at the Springfield meeting, two years ago, beg leave to submit the following report:

Realizing that this subject was one of the utmost importance to the various members of the Association, especially to those connected with the management of water works, and knowing that if any changes were made, those which would necessitate the fewest changes in the present rates of the largest number of works, would be preferable, your committee first attempted to collate the largest possible number of the rates at present in use in the country, and, to that end, sent circulars to every water department, both public and private, in the United States and Canada, inclosing with these circulars a return envelope and asking that they be favored with a copy of the existing rates, together with such suggestions as each particular Superintendent, Water Registrar or Commissioner would suggest as being of value in this matter; a large number of replies were had and to those who did not reply to the first circular a second one was sent enclosing a return envelope with stamp, this second attempt brought a few more replies, which with those first received made a total of about 450 or less than one-half of the total number of works in the country to whom we had applied. Your committee had thought the subject of importance enough to have given them many more replies, but unusual apathy, or indifference seemed to exist in some sections of the country.

The next step was to classify and tabulate these reports that an intelligent study of the same might be made, for this purpose we obtained large sheets, specially ruled with 23 different vertical columns, and detailed on them, in alphabetical order the various rates obtained. The different headings used were as follows:

1st. Rate for faucets in dwellings, boarding-houses, etc.
2d. Rate for water closets and urinals.
3rd. Rate for bath tubs.
4th. Rate for hand hose.
5th. Rate for stables.

These five columns including the principal domestic uses.

6th. Rate for offices.
7th. Rate for barber shop.
8th. Rate for stores.
9th. Rate for markets.
10th. Rate for bakeries.
11th. Rate for breweries.
12th. Rate for laundries.
13th. Rate for saloons.
14th. Rate for public buildings.
15th. Rate for manufacturers.
16th. Rate for engines.
17th. Rate for wharfs.
18th. Rate for public drinking fountains.
19th. Rate for fire hydrants.
20th. Rate for public watering troughs.
21st. Rate for street sprinkler.
22d. Rate for meters.
23d. Rate for building purposes.

These last eighteen rates comprising all of the principal natural divisions of the uses of water besides those for domestic purposes, each of these headings have been subdivided in particular cases as circumstances required.

After completing this tabulation we proceeded to make a careful study of these sheets and soon found that there was no uniformity whatsoever about the different rates. In some instances while the rates for water closets were the same in a dozen different places, in the same places there were a dozen different rates for bath tubs, showing that the compilers of these rates had different ideas as to the amount of water required for the different uses, or else, as is probably the case in a large majority of instances, the rates have been fixed with very little regard to the probable amount of water consumed, but more to meet ideas as to the amount of money which could probably be collected with the least friction, in the various places for the different uses.

Nearly if not quite all of the different rates have what may be called "a basis rate," that is a rate for the domestic use of one faucet, but here all uniformity ends. It is true that nearly all have rates for the use of different fixtures common to all, such as closets, baths, &c., but the *relative* charges for these are hardly the same in any two places.

The introduction of water into any city or town is, primarily and principally, for the preservation of the public health. It is to provide a substitute for the contaminated wells found in all settlements, or to furnish water for domestic uses in those places where no water can be obtained within the limits of the place. After serving this direct and first use it is wanted as a solvent and carrier to render harmless and to remove the wastes of the population and prevent the accumulation of matter deleterious to the public health. These uses are paramount to all others, no matter how convenient or valuable others may be, consequently it is evident that the water furnished must be as near pure as possible and be placed within reasonable reach of all.

I think it will be admitted by all that one faucet is sufficient to supply all the *necessary* wants of several families, but that the custom, prevalent in many Southern and Western cities, of placing a faucet, or hydrant as they are called in those sections, in an area or alley way where they are accessible to many different families is unwise, as it not only places the same where no one is responsible for it or feels bound to keep it in order, but it has a tendency to render the consumer careless and wasteful when the opposite should be aimed at; this is especially noticeable in the city of Washington where the practice results in the largest consumption per capita per diem in the country. It is better, therefore, under all circumstances, to insist that each family desiring a supply shall have a separate faucet placed within its own apartments and for its own use.

What shall be charged for the use of water through this first faucet is an important question and must be settled by each department for itself, but a uniformity of basis for this charge is desired and I believe can be had, but whatever the basis, the charge should be as low as possible and I do not think it will ever be commensurate with the cost or value of the water used when considered as "water under pressure." The price must be low that it may not prohibit the use of water by the poorest, who need it, usually, more than any one else, and in some sections of many cities its use had better be compulsory than not at all.

As before stated the annual rate to be charged for this first faucet must be determined by each department, but there must be some uniform basis for this charge as it is neither necessary, to meet the requirements of the case or policy, to charge all domestic users of one faucet the same, we must have some minimum standard or measure to regulate it. It is of course not feasible to place meters on single faucet services, as the average cost to maintain a meter, including interest and depreciation, is about $4, and this is nearly the amount which I find is the minimum charge for the first faucet in many places, therefore we must look for some other standard. The different ones in use at present are as follows, they being given in the order of least use.

1st. A minimum charge per family without any limitation.
2d. The number of stories in height of the building.
3d. The assessed value of the property.
4th. The number of feet front in the lot.
5th. The number of persons in the family.
6th. The number of rooms occupied by the family.

In all but the first the rates are graduated ones, i. e., for the minimum, a certain number or amount of the integer used as a basis being taken and then increased as these integers increase.

In considering these I hardly think we need spend much time on the first one, but dismiss it as being in this age both crude and unbusiness like, although simple.

The second, the number of stories in height of the building, is on its face insufficient, and while perhaps it is a scale, yet it is too primitive a one to have any practical value.

The third one, the assessed value of the property, is the first one which is worthy of much consideration: at first thought it might seem that the more valuable the building the more it should pay, this would be true if you intend to charge nothing for the water, but practically raise your revenue by a system of taxation on the property, but if you do this you should assess all the property in the municipality and let those use the water or not that might be willing to pay the cost of connecting their property with the mains, this system is in vogue in a few Western mining towns, but the insufficiency and inequality of this standard is seen when each of us think of different properties with which we are personally familiar; we know that of two buildings one may be intrinsically worthless while the other may be solid, well built and durable, yet the former may be assessed the most, on account of its location or other circumstances, in such cases the standard is not perfect; again, a man may have committed the common error of putting his all into a valuable house, not necessarily a large one, but substantial, and then through sickness, adversity or old age be in reality poorer than the man who lives in a $200 shed and yet earns good wages; for these and many other reasons which could be named I hardly think the assessed valuation of the property meets all the requirements of the standard we are seeking.

The fourth one, the number of front feet in the lot, need no more be considered than the second one, the number of stories in the building, as it bears no more relation to the subject under consideration than would the avoirdupois of the owner of the property.

The fifth one, the number of persons in the family, is the best standard we have yet considered; it is true that some people are careful and others are extravagant in the use of water, some economical and others wasteful, some appreciate that water has a value while others think it should be "free as air," still, in this connection, the first faucet, the one absolutely necessary and essential fixture, we must place people on an equality and try to prevent extravagance, waste and misuse in connection with this one faucet by education, watchfulness, inspection and possibly fines.

It is admitted, I believe, that 20 gallons of water per capita per diem are sufficient for all the wants, necessities and luxuries of domestic life, and that half of this, or ten gallons is sufficient for the wants and necessities without the luxuries; this in an average family of five persons at 25 cents per 1000 gallons would amount to $4.56 per year, so you see how small a sum would pay for the necessities of domestic use.

The great and only objection to this standard is the difficulty in determining how many persons there are in a family. They don't want you to

count the baby, "he uses milk," nor the grandmother, "she don't use any water," nor the scholar, "he gets all the water he uses at school," nor the boarder, "he is only here a little while," nor the son, "he is just home on a visit and is going back to the city to-morrow," &c., &c. You are met on every hand by evasions and objections and it is a hard and thankless task, and would at the best be constantly changing; the very fact of our existence as a nation and our multiplicity of occupations, accounts for this, hence this is not a satisfactory standard, although we may not be able to find one much better, still I am inclined to think the sixth one, the number of rooms, living rooms, is nearer the desired end than anything else.

In examining our Massachusetts census reports we find that the number of inhabitants in the State and the number of living rooms in our dwellings are practically the same.

The number of rooms can always be ascertained without question, they only change at rare intervals and, as stated, each room averages to be the abiding place of one person.

Some may object to this standard as in the poorer houses they are apt to be many more individuals than rooms, I grant it, but they are the ones usually least able to pay large sums and the ones to whom it is of the utmost importance a supply of water should be furnished, as a matter of self preservation, for in most cases contagious diseases start in such places.

If the number of rooms should be adopted as a standard you would have one that could be easily determined at all times and that would meet all the requirements of the case and attain the end desired in relation to the first faucet for domestic use.

It is important that there should not only be a uniform basis, but that there should also be a uniformity in the number of rooms allowed for the minimum charge and then an additional charge made for each additional room and your committee recommend, as they will do again in their summary to this paper, that for the minimum sum for which any department will furnish water for domestic use, each family, using one faucet, and occupying a tenement of five rooms, or less, shall be entitled to all the water they need, not waste, and for each additional room they shall pay 20 per cent. more.

We will suppose that your minimum rate is $5, the annual rate book would read as follows:

For the first faucet, to be used for domestic purposes only, by a family occupying a tenement of five rooms, or less, the annual sum of $5 shall be paid and for each additional room, the additional annual sum of $1.

If your minimum rate was $4 then the charge for each additional room would be 80 cents, while if the minimum charge was $6 each additional room would be $1.20 and so on.

Having determined the basis for the minimum annual rate, the next question is, what proportionate amount of this shall we charge for additional faucets.

In interpreting the meaning of the word faucet, in this connection, it is intended to mean only those at a sink or basin, not those at a bath, drinking trough or other place, and if a hot water boiler is used there should

be no extra charge for the hot water faucet, unless used separately; when both a hot and cold water faucet are over a sink or basin it will be classed as one.

You are of course all familiar with the invariable reply of the average customer when you attempt to charge him anything for extra faucets, "I use no more water with two faucets than I do with one, my family is the same, we do not wash any more thoroughly or frequently, or drink any more," &c., &c. To this we must needs reply that there is no natural relation between the minimum annual rate for the first faucet and the rate to be charged for additional ones, in the first case we do not pretend to charge, and we know we do not get pay, for the water used, the question of necessity rather than quantity or convenience being the governing power, but when your necessities are supplied by the first faucet any further use of water by a multiplicity of fixtures, becomes a convenience, a luxury, or a matter of business, and for such it is both mete and proper that the customer should pay, just how much is the question.

After many inquiries and as much study of the subject as I could give it I conclude that there is no uniformity in the amount of water used through the second or additional faucets by different customers, a great deal depends on the location of these faucets, but more on the personality of the customer, but as nearly as I can decide, although it is largely conjectural, the average amount of water used through each additional faucet, in an ordinary dwelling, is about 25 per cent. of the amount used through the first faucet, and if the rate for the first faucet were based on the absolute quantity of water used, it would be an easy matter to determine a rate for additional faucets, but as this minimum rate is merely an economic, or politic, rather than a quantitive one, we cannot accurately make comparison in rates with it, but I believe that a rate for additional faucets of 40 per cent. of the minimum rate for the first faucet, will be as nearly equitable as we can determine it; that is, if the minimum rate for the first faucet is $5, each additional faucet should be charged an annual rate of $2, for a tenement of five rooms or less, and 40 cents for each additional room.

After having supplied your dwelling with one or more faucets at a sink or basin the introduction of other fixtures such as closets, baths, urinals, &c., indicate a possession of a sufficient amount of this world's goods to warrant the indulgence in what might be called the luxurious use of water, and as such indulgences can never be expected to be had without cost it is proper that they should be paid for, but as it is not a question of necessity nor the preservation of the individual, or public, health, it is evident that the reasons which have governed the establishment of the minimum charge for the first faucet should not govern the charges for the additional fixtures; but that they should come under what might be termed a quantitive charge, that is, the man who has the most fixtures and uses the most water, although he may have a small house and family, should pay the larger sum.

Your committee have endeavored to ascertain by letter, by observation, by a study of existing publications and all other means which came to their hands what was the average amount of water used in each of these

different fixtures which may be called luxuries, but they have been unable to obtain any data that was at all reliable and we have been thrown back upon the custom, at present in vogue, of making the rate, if it is made arbitrarily, sufficiently large to cover all question as to the amount of water used. We find the rate for bath tubs in a private family varying from $2 to $15, for water closets from no charge for the first one to $18, and this in places where there is apparently no reason for the great difference, in places where the cost of construction, maintenance and operation are presumably about the same, and we cannot explain these great differences.

If you make arbitrary rates for these fixtures they must be sufficiently large to cover the extravagance, the wastefulness and the carelessness of the most ignorant customer and in so doing you will probably charge nine-tenths of your customers more than they really ought to pay, and in some cases this charge will be so high that a man of small family, carefully brought up to respect the rights and property of others as well as his own, will have just cause to grumble and complain at the rule which makes him pay for his neighbors extravagance. This is not equity and should not be so. In case the Association should think best to recommend fixture rates, for these fixtures which may be termed luxuries, they would needs have to know, what would, in all probability, be the relative amount of water used in the different fixtures, but your Committee is utterly unable to enlighten them on this subject, although, as before stated, they have made it a matter of special study, and your committee would not recommend to the Association the fixing or establishing of arbitrary fixture rates for this class of fixtures; but, on the other hand, would recommend that for all uses other than through plain, simple, faucets, over sink or basin, the customer should be obliged to furnish and maintain a meter, at his own expense, or else pay the department for so doing, and pay the department an annual minimum rate for the privilege of having and using the water, which minimum rate would enable him to use a certain stated number of gallons of water each quarter, but any excess above this amount should be paid for at established rates.

If this system is recommended by the Association, it becomes important to determine what the minimum rate to be charged should be. To determine this we examine some of the general fixture rates throughout the country and we find that the rate most common is as follows:

For the first faucet, used by one family, per annum, $6.

For each bath tub $5.

For each water closet $5.

For each additional faucet, after the first, $2.50.

We will suppose that the above fixtures constitute the average number in use in an average family in moderate circumstances, and that, instead, of charging them the rates above we desire to charge them by meter, obligating them to pay a certain sum per annum for a certain quantity of water per quarter and in addition pay for any excess which they may use. You will see that the sum of these rates as given above is $18.50 and this is about the average rate per customer in a large number of places whose reports we have examined; but at 25 cents per thousand gallons this

$18.50 would pay for a much larger quantity of water than we know is necessary for an average family using these fixtures. Again, another family may have but one water closet besides the first faucet. This would make his fixture rate on the above basis $11 and on the supposition that this $11 is sufficient to pay for the average amount of water that he would use it would hardly be right to make our minimum meter rate $18.50 or as large as the present average fixture rate of all circumstances. We should, therefore, make it such an amount as would be about equal to our minimum charge for the first faucet plus the fixture rate which we would charge for one of these, so-called luxury fixtures, if we had established as a standard, so-called, fixture rates. This of course will vary in different sections of the country, but I think there is hardly any case in which it would be much less than $10. We will assume, for the purpose of completing a supposed tariff of water rate, that the minimum charge for water meters shall be $10 per annum and that for this sum the consumer should be entitled to use ten thousand gallons of water in any quarter, and that for any excess in any quarter he should pay according to the meter rates established.

To show that the above amount of water is sufficient for all the uses of an average family of five persons we take 20 gallons per capita per diem as being the acknowledged average amount required, multiply that by five and again by 91¼,—the number of days in each quarter,—and we find that 9,125 gals. per quarter is sufficient for the average family and it is, therefore, fair to presume that any larger use than this is either the result of carelessness, extravagance or want of watchfulness in seeing that the fixtures used are in proper condition.

During the past year the writer has had more than one hundred individual cases called to his attention of the wisdom of a rate similar to this recommended, especially in the promptness with which leaky faucets, burst pipes, &c., have been reported by the occupant of the premises supplied, and the same either repaired at once, or the department requested to turn off the water until the same could be repaired. The reason of this watchfulness and care being that the leak, or other cause of waste, was depleting the pocket-book of the customer rather than of the water department.

Your committee recommend making the collection and the averaging of rates and consumption quarterly rather than semi-annually or annually as thereby the customers and the details of the department are better in hand and a greater familiarity and confidence between the department and the customers is established.

Your committee further recommend that these rates be payable quarterly in advance and that at the beginning of each quarter the metered customer pay for the excess of water, over the regular allowance, which he may have used during the preceding quarter.

In relation to the rates for other than domestic uses your committee are clearly of the opinion that nothing but meters should be allowed, and that the minimum rate and general conditions governing the same should be as recommended for domestic meters.

In support of this recommendation we would cite several instances of different uses which have come under our observation. In one city there were three barber shops, each doing apparently the same amount of business, each having the same number of chairs, bath tubs. basins, etc., and still the amount of water consumed by these different shops, as indicated by meters, was in one case twice that of another shop and in the third case nearly four times that of the former, the entire difference being caused by the different class of attendants employed and the fact that one out of the three kept his fixtures in good repair while the others paid but little attention to the same. In another instance, in a large public market, which was supplied by a two inch meter, in order that the stalls and passage ways might be quickly and readily washed off by the use of hose, the amount of water consumed for five months averaged, per day, as follows:

First month 39,000 gallons per day.
Second month, 42,000 gallons per day.
Third month, 40,000 gallons per day.
Fourth month, 19,000 gallons per day.
Fifth month, 18,000 gallons per day.

The sudden and marked change occurring at the end of the first quarter, when the bill was rendered which called the attention of the Superintendent of the market to the fact that it was cheaper to pay for a piece of good hose than it was to pay for the water that leaked from every pore of the piece he was using; also that it was not economy, after a sufficient amount of water had been turned onto the floor in one stall, to throw the hose down and allow the water to run from it and to waste, while the attendant swept the floor of that stall.

In relation to the charge for steam engines, so great a difference exists in the economy of the operation of boilers generating steam for power that no arbitrary rate per horse power would be equitable. In some instances we found a boiler rated at 40 horse power being crowded to 60, in others we have found one pound of coal evaporating four pounds of water, while in others the one pound will evaporate nine to eleven, so we could not use, even if practicable to obtain it, the weight of coal consumed, in determining the rate to be charged for boilers

There is only a very small per cent. of the generators of steam power who know the weight of coal consumed; they either keep no record of it, or the coal is used for other purposes and to insist on their putting in scales and weighing the coal to the boilers, would be much more difficult than to insist that they should put in a meter.

In other branches of business, many of which are detailed on the sheets of rates mentioned, we find differences of practice to exist equally unsatisfactory and inaccurate as those cited and it would be as difficult to attempt to establish arbitrary rates that would be equitable, as it would be to establish an exact uniformity in dress, habits and general appearance of all mankind. Your Committee are therefore of the opinion that no water should be sold for other than domestic uses, except the same be measured by meter, or some form of registering or recording device.

As regards the feasibility of charging the consumer with the cost and maintenance of the meter, or having him pay the department a sum which represents this, we would say that we see no more objection to this than we do to making the customer pay for his faucets, hose or other fixtures about his premises; they are both, in a certain sense, measures, as the size of the faucet, or hose nozzle, determines the amount of water that can be delivered, and there is hardly a department but what regulates, at the present time, in a greater or less degree, those sizes, excepting those departments which have already established universal meter rates. The customer is apt to say that they should no more pay for the meter than they should each buy a pair of scales to weigh the sugar which they buy of the dealer. To this objection we can reply that the dealers do not have to buy or furnish a pair of scales for each package or quantity they sell, otherwise he might insist on the customer furnishing the same, with propriety, and in general we think it is safe to say that, if each customer did buy, and maintain, a pair of scales with which to weigh the various commodities they purchased that the scales would very soon pay for themselves.

As to the cost to the department for furnishing meters, we would say that it of course depends upon the pattern of meter used and the quality of the water measured. There are several meters, now on the market, which cost from $12 to $15 each, for the average house sizes, or including setting, from $15 to $18, and we think it is safe to say that the average first cost of all meters used would be about $20 each, set. The average life of meters is not yet determined, but we hardly think it would be over 10 years and in some very gritty water it will be much less, but on the assumption that the meters cost $20 set, money worth 6 per cent. and that the meter will wear out in ten years we have an annual cost for the same of $3.20 without allowing anything for repairs, which should not be more than 50 to 75 cents per year, or at the outside the entire annual cost of a meter should not exceed $4, and I think a department could well afford to furnish meters to all their customers at an annual rental of $4 each, and charge the customer the minimum rate for their water, and that at the end of the year, both the customer and the department, will be better off than if the almost free and unrestricted use of water was allowed, at fixture rates.

Of the pecuniary advantages accruing to departments and customers by the almost universal use of meters we could cite you many places, notably Pawtucket, R. I., Fall River, Mass., and especially Atlanta, Ga., where the change from fixtures to universal meter rates was practically accomplished in two years time, without decreasing the revenue of the department, or the average amount paid per customer, while, at the same time, the amount of fuel was reduced over fifty per cent. and the necessity of laying several miles of new and larger force main was put off for several years to come. At Atlanta I believe the customer furnishes his own meter, approved by the city, and pays for the same, set, a uniform price of $25 each, without regard to size. The minimum rate charged by the city for the use of water is $10, per annum, and 17 cents per 1000 gallons for all excess over 10,000 gallons per quarter.

In conclusion your Committee would say, that, as a result of their study and investigations, and for the reasons stated herein, as well as for many others which have presented themselves to them, they cannot recommend or advise any system of arbitrary rates based upon size, number or kind of fixtures used that would be either satisfactory or equitable to be adopted, as a standard, and in lieu thereof they recommend that all uses of water other than through plain faucets by domestic consumers should be measured by meter and paid for accordingly, and as a sample of a standard form for water rates would recommend the following:

For the first faucet, to be used by one family for domestic purposes only, in a tenement of five rooms or less, the annual sum of $———; for each additional room, the additional annual of $———; (20 per cent. of the former sum), for each additional faucet the additional annual sum of $———; (40 per cent of the foregoing sums), all to be paid quarterly in advance.

Whenever water is used for other than domestic purposes, or more and other than plain faucets are used, then the water shall be supplied only through a meter, of a pattern to be approved by the Manager of the Water Works, to be furnished and maintained by the consumer, at the minimum rate of $———per year, payable quarterly in advance; for this sum the consumer shall be entitled to use as much water as he desires, not to exceed 10,000 gallons in any one quarter; all excess above this, used in any one quarter, to be paid for at the uniform rate of———cents per thousand gallons, at the commencement of the next quarter. Reasonable discounts to large consumers will be made.

DISCUSSION.

The Chairman. You have heard the report of the Chairman of the Committee on water rates, which has just been read by our Secretary, and the subject is now before you for discussion. Mr, Darling usually has something to say upon this subject, and shall we not hear from him now?

Mr. Darling. Our rate is fixed by faucet at five dollars and our price beyond two faucets is the meter rate. In our outside division, where we lay pipes in other towns, the takers pay for them themselves, but in Pawtucket we pay for them, that is for the ordinary standard meter. If they want anything different from that they pay the difference between it and the price of the meter. I believe the only true way to sell water is in that way, and I have believed so for many years. The members of this Association have heard me discuss this question again and again, and, perhaps, more than they have desired, and, now, I should like very much to hear from some other gentleman. Our revenue is perfectly satisfactory and it is increasing every year, and we are not using a larger quantity of water. Our average consumption last year was 2,200,000 gallons a day, a fraction over, and our revenue was about $80,000. This year, I suppose, we will use a little more, and the revenue will be a little more. We have already taken in $70,000. I have always taken the ground that the rates should be made as low as possible, and I introduced the meters into our town in order to give the laboring man and the mechanic an equal advantage with the rich man. By introducing the meter and making the minimum rate of $10 per meter, the

poorer man can have his garden hose, he can have the water for his garden, he can have all the faucets he wants in the house, and it wont cost him but $10 for the whole of it. He can have his bath tub and water closet and everything the same as a man who has a fine house, and $10 will cover the water bill. A great many services we have don't use $6 worth of water, and yet they pay us $10. We have made the works popular and everybody wants the water. There isn't a house, now, that has a well; they know the water wont cost them but $10 a year and they want it.

Mr. Hawes, Do you make any difference to very large consumers?

Mr. Darling. Yes, sir. The family rates are 30 cents for 1000 gallons; from one to three thousand, 27, I think; from three to five, 25; from five to seven, 20; and so on down. A man who is using 10,000 gallons a day buys it for 10 cents, then 8 and then 7, and for 100,000 gallons a day it is 6 cents a thousand gallons. I have three customers who are using 100,000 gallons a day or more, and they buy it for 6 cents a thousand gallons.

Mr. Hawes. Do they use it for condensing purposes?

Mr. Darling. They use it for any purpose they see fit. The large customers are manufacturing companies. The Conant Thread Company are using about 160,000 gallons a day; the Lonsdale Company are using some over 100,000 gallons a day, and we have a great many who use ten to twenty thousand gallons. The rate runs from 30 cents a thousand gallons, the family rate, down to six cents. The gross receipts this year will be about $90,000, and we supply a population of about 40,000. We have five divisions to our works and keep five sets of books, but it is practically one works. Our pumping engine pumps the water into the receiving reservoir and pipes.

Mr. Tidd. Has the city any water debt unpaid?

Mr. Darling. Oh, yes, sir.

Mr. Tidd. Can the gentleman tell us what the water costs him, including interest on the debt?

Mr. Darling. Our present debt is about $1,200,000. We bond everything; our construction account is all bonded every year. I have just about completed a large storage reservoir, which, when completed, with the dam, land and everything, will cost about $150,000, and that has all been bonded. We pay the interest on the debt, and running expenses of the works, and we were able last year to pay $10,000 into the sinking fund.

Mr. Tidd. What I want to get at, if you can tell me, is what the water costs you to pump, including the interest on the debt; whether, when you sell it for six cents you get back what it costs you to pump it.

Mr. Darling I should naturally say we did, since we are able to pay the interest on the whole debt.

Mr. Tidd. I mean at the lowest rate, six cents a thousand gallons.

Mr. Darling. Perhaps not if it was all sold at that price. It costs us about $13 a million gallons to pump it. That includes coal, labor, oil, waste and everything; and, of course, the more we pump the less it costs us in proportion.

Mr. Tidd. The interest, of course, is a legitimate expense, and I was thinking that perhaps at the lowest rate you were not getting all the water cost you.

Mr. Darling. I think if it costs us $13 a million gallons to pump it, and we have the tools to do it with, and we can get $60 for it, it is a very fair investment. You have got to run the engine and keep the men just the same, and if you can get some large customers at that rate, I think it is profitable to do it if it only costs you $13 and you can get $60. I have included in the expense of pumping interest on the plant. In other words, I think if the plant costs us so much, and isn't but seven years old, with pipes laid that are large enough for 10,000 customers and we have only 4,000 now, and we are able to pay the running expenses of the whole concern and transfer $10,000 a year into the sinking fund, it is about as good a showing as we would want to make for a stock company.

Mr. Tidd. That may be, but aren't the small consumers being taxed to pay the bills?

Mr. Darling. No, sir, because the small consumer is getting his water for $10 and it would cost him $18 to $20 under the faucet rate.

Mr. Tidd. If the large consumers are getting it for less than cost, the small consumer must be paying more.

Mr. Darling. I don't think they are getting it for less than cost, when I am pumping it for $13 and selling it for $60. Of course, the interest on the debt is not increased by doing this: if you didn't do it, the interest would be just the same. Our bonds bear interest from 3½ to 7, and the average is a little less than 5 per cent. Our last bonds, 4 per cent, sold for 108. Our interest account is about $60,000. Our sinking fund to-day is about $275,000. I believe if we continue in the way we are and the works increases in the proportion in which it has, or in comparison with other works, that in 20 years time it will pay the whole debt, principal and interest, and the running expenses, without a cent of taxation to the town.

Adjourned to Thursday at 9 A. M.

THURSDAY MORNING SESSION.

The convention was called to order at 9.20 A. M., Vice President Kent in the chair.

The Chairman. The first business is the distribution of sketches, and, I presume, some remarks from the Chairman of the committee.

Mr. Sherman. The committee would suggest that perhaps the most proper time to distribute these sketches would be just before the reading of Mr. Parker's paper. Among the sketches is a blue by Mr. Parker, and it would be interesting to have it before us while he is reading his paper. We would prefer to defer the the distribution until just before that time.

The Chairman. If there is no objection it will be deferred. The next business is the election of officers; is the committee ready to report.

ELECTION OF OFFICERS.

Mr. Hall. In behalf of the committee to nominate officers for the ensuing year I will make the following report, for:

President—Edwin Darling, Superintendent, Pawtucket, R. I.

Vice Presidents—Desmond FitzGerald, Superintendent West. Division, Boston, Mass.; Willard Kent, Superintendent, Woonsocket, R. I.; Charles K. Walker, Superintendent, Manchester, N. H.; F. H. Parker, Superin-

tendent, Burlington, Vt.; George P. Westcott, Superintendent, Portland, Me.; J. C. Broatch, Superintendent, Middletown, Conn.

Secretary—R. C. P. Coggeshall, Superintendent, New Bedford, Mass.

Treasurer—Albert S. Glover, Registrar, West Newton, Mass.

Senior Editor—George F. Swain, Professor of Civil Engineering, Mass. Inst. Technology, Boston, Mass.

Junior Editor—William R. Billings, Superintendent, Taunton, Mass.

Executive Committee—Frank E. Hall, Superintendent, Quincy, Mass.; Walter H. Richards, Superintendent, New London, Conn.; Albert F. Noyes, City Engineer, West Newton, Mass.

Finance Committee—George E. Batchelder, Registrar, Worcester, Mass.; Phineas Sprague, Registrar, Malden, Mass.; James H. Hathaway, Registrar, New Bedford, Mass.

Mr. Richards. I move that the report be accepted, and that the Secretary be directed to cast the vote of the Convention for the list of officers as reported by the committee. Adopted. The Secretary cast the ballot and the officers were declared elected.

A SALARY FOR THE SECRETARY.

Mr. Parker. We all know that this Association has increased in membership very much, especially during the last two years, so that the position of Secretary is no longer an honorary one, but involves a great deal of labor and drudgery. At the meeting a year ago the matter of paying the Secretary a salary was discussed, and at the request of the then Secretary the matter was dropped. But it seems to me, sir, that at this time it is no more than right that we should vote to pay our Secretary a salary, not so much for the work which he may perform but to enable him to hire some one to perform the drudgery and routine of the office. In order to bring the matter before the Association, I move that the Secretary be paid a salary of $300 for the ensuing year.

Mr. Richards. It seems to me it would be a good idea to authorize the Secretary to employ such help as he sees fit and to pay whatever is necessary to pay, whether it be $300 or $500 or $100.

Mr. Glover. It may, perhaps, be a little indelicate for me to say anything about this matter, Mr. Chairman, but I can appreciate, probably, as much as anybody the amount of work it is necessary for the Secretary to put into his office in order to get the best results and to do the duty for which he is elected. It seems to me that Mr. Parker's suggestion is a good one, and that the salary should be a fixed sum. If the Secretary were only authorized to employ such assistance as he might need, he might, perhaps, refrain from employing assistance that he really needed, rather than to give for it an amount which he might think the Association might think he was not justified in expending. As I have had considerable experience in the work, I feel sure that $300 a year is no more than the Secretary should be allowed to expend, and it seems to me better that the sum should be fixed as a salary out of which he shall pay all expense of clerical service or of anything it may be necessary for him to have in the discharge of the duties of his office.

Mr. Darling. Would that include the shorthand reporter?

Mr. Glover. No, that would be a matter, of course, for the Association.

Mr. Sherman. I would like to ask our Secretary if he can give us in round numbers the probable cost for the past year of like service. I do not know anything about it, but I presume he has been obliged to hire this work done, and, perhaps, he can give us an idea of the amount he has had to pay.

Mr. Glover. I have the figures at the hotel; I should say it was in the neighborhood of $125. But I could have spent judiciously, I should think, from $600 to $1000 for the benefit of the Association, and I should like to have had the opportunity.

Mr. Sherman. That is the point I wanted to reach, that for the past year the results we have had have cost us $125. I entirely agree with Mr. Glover that we could spend $600 to $1000, but the question comes right home to me, where is this money coming from? We are growing in numbers, that is true, but we haven't got the funds to carry this thing along in the way we would like to. We have got to do with what we have. We do not want to run into debt. I would like to see the Journal, perhaps, elaborated in some ways, but we haven't got the funds to lay out in that way. I think the surplus money at the end of the year can be spent in more practical ways. However, if the treasury can stand an expenditure of $300 per annum for this, I am perfectly willing it should.

Mr. Glover. The money that would be expended by the Secretary would, of course, be for the advantage of the Association. We have grown very largely in the last two or three years, and that growth is the result of an output of money. The amount the Secretary would spend, if this $300 is voted him, would all be for the benefit of the Association. I think the more we put out in that way the more the Association will grow, and the more benefit we will all get. If we limit the Secretary to $125 we won't get as much good as we would out of a larger amount. We can afford to give him $300. The work is worth it; and it will not put the Association in debt; I had just as lief guarantee the Association that.

Mr. Parker. I understood that the Association had come out this year with $500 in the treasury. With the increased membership I do not see why the receipts would be less this year. Another thing that occurred to me was that this year there has been a great amount of work put upon the editors, and if we had paid a Secretary a certain amount of such work might be turned over to him, and in that way the Board of Editors be relieved somewhat.

Mr. Billings. I sympathize wholly with the cautious spirit which Mr. Sherman exhibits in wanting to know exactly where the money is coming from before we vote to expend it. But I have such perfect confidence in the future of this Association that I am perfectly willing with Mr. Glover, or any other gentleman, to agree to pay the whole of the $300 if we don't come out next year with a balance in the treasury. We have a balance of some $500, according to the Treasurer's statement, but in addition to that there are some uncollected bills, which are perfectly good, amounting, if I remember right, to about $200 more. Fifty dollars expended in clerical labor would probably call in, in ten days' time, the whole of that $200. I have not the slightest fear about raising the money, if the policy which has been pursued the past year be continued through the coming year.

Mr. Noyes. I might say a word or two in addition to what has already been said in reference to the duties of the Secretary. Having been associated quite closely, officially, with our present Secretary, Mr. Glover, I know something of the very arduous duties which are connected with the office, if the work is done as it ought to be done to properly advance the interests of the Association. I also know something of the work which our Board of Editors have done. As you all know, these gentlemen are officers of departments of considerable size, and it requires very close attention to manage them. I think we cannot appreciate too highly the work they have done; and in order to prevent the temptation to neglect other duties, it is necessary we should give them assistance in doing our work. It seems to me that the good the Association will get from the expenditure of the $300 which it is proposed to pay for this work which ought to be done will be worth all it will cost and far more. I heartily approve and shall vote for the motion made by Mr. Parker.

Mr. Darling. I would ask the Secretary what the probable income from advertising will be.

Mr. Glover. Besides answering that question, Mr. Chairman, perhaps it will be well to state our whole estimated income for the year. With our present membership the income should be $600 from dues. Our advertising last year paid us between $900 and $1000. It was started year before last and conducted something in the nature of an experiment. The matter was referred to me by the Executive Committee with full powers, and I sort of guessed at the rate that should be charged for advertising. We didn't wish to make any money. We started the Journal with the idea that we might get enough advertising to pay for publishing it, and, having estimated it might cost us $1000, we restricted the amount of advertising to that. I do not doubt that the amount of money from advertising could be doubled without much effort. There is no question but what the Journal is a first-class medium for advertising, and I have no question at all but what the income could be very largely increased, and I think almost certainly doubled. In my mind there is no question at all but what the Association can afford to pay the Secretary $300, and I believe, moreover, that is the just and proper thing to do. I hope Mr. Parker's motion will be carried and carried unanimously. I had some little talk with Mr. Coggeshall a few days ago, I may say, with regard to the Secretaryship. My attention to the duties of the office has subjected me to more or less criticism, and I made up my mind that I ought not to hold the office any longer. As Mr. Coggeshall had been Secretary before and was on that account more familiar with the duties of the office than anybody else, it seemed to me probable that he would be elected at this meeting; but on talking the matter over with him I found him very reluctant to assume the work. He said he realized it had grown immensely since he was Secretary. At that time the membership was only about thirty, and the work, in comparison with what it is to-day, was very little; meanwhile his duties as Superintent at New Bedford had increased, and, as I say, he was very reluctant when spoken to about taking up the work again. And from the conversation I had with him I feel he would only be willing to do it on condition that this money was put at his disposal, not

as a personal salary to him for any labor he may perform, but as a fund from which he can draw for the employment of somebody to do the work which might otherwise be thrust upon him at a time when his own private or official business required his attention. I feel perfectly safe, gentlemen, in guaranteeing you that you can pay this salary of $300 without any detriment to the funds of the Association, and I sincerely hope that Mr. Parker's motion will be adopted by a unanimous vote.

Mr. Darling. I have felt ever since we were organized that the work of the Secretary should be paid for. We have tried heretofore to fix a salary but we have never been able to get our Secretary to take anything, he preferring to do his work as a labor of love, and thinking it was better for the Association to learn to creep before it attempted to walk. But I can see that there is a great amount of labor to be performed. If this advertising is to be continued I can see where we will receive a revenue from the Journal, and if the people who are advertising in it are satisfied, of course, there is no question but what it will be continued. But I do feel as though we wanted to keep our expenses within limit so we can add a few hundred dollars every year to our fund. My desire is for this Association to have a fund of anywhere from three to five or eight thousand dollars. Some of you may ask, "What are you going to do with it?" Now, I have got it into my head in this way: I am presuming that there may be a case where some one of us,—I will speak of myself,—may become poor; I may in some manner or other need assistance from you people, and wouldn't it be quite pleasant for you to turn around and make me a donation, if I should get into such a pocket? (Laughter.) I speak for myself; I won't speak for any of you people who think there isn't any danger of your ever getting into such a place. (Laughter.) But, I say that a fund back of an Association like this, a good live fund of $3000 or $5000, gives it a standing and gives it a stimulus. I am willing you should spend your money for printing, for everything that is absolutely needed, and that will assist the Association and make it better and better. I want to see that done, but I want in the meantime to have a reserve fund laid up every year. That is the point I make. Now, if $300 is a fair price, and the revenue is going to allow us to pay it, I for one am perfectly willing to have the salary of the Secretary fixed at $300. And this has been discussed pretty thoroughly, and it seems to me it is the proper thing, I will second the motion that the salary be fixed at $300.

Adopted.

EXCHANGE OF FRATERNAL GREETINGS.

Mr. Glover. I have here a telegram which I will read:

KANSAS CITY, MO., June 14, 1887.

Henry W. Rogers, President New England Water Works Association:

HOTEL WINDSOR, Manchester, N. H.

In behalf of the American Water Works Association which convenes at Minneapolis, July 13th, I send your Association fraternal greeting, may you live long and prosper. We would be glad to see as many of your members as may find it convenient to meet us at beautiful Minneapolis.

B. F. JONES,

President American W. W. Association.

Mr. Billings. I move that the Secretary be instructed to prepare and forward a suitable reply to the telegram which has just been read, expressing the appreciation of the Convention of the courtesy of the American Association.
Adopted.

The following paper was read by Frank L. Fuller, C. E., of Boston.

WARE WATER WORKS.

The town of Ware is situated in the southeast corner of Hampshire Co., about midway between the cities of Springfield, in Hamden County, and Worcester, in Worcester County.

The earliest historical facts on record concerning the town go to show that the Indians sold a tract of land, embracing the present village, in 1686. The first mills were built by Jabez Olmstrod, who came to Ware in 1729. In 1742 there were 33 families, and in 1761 the town was incorporated. The first church was built in 1751 at Ware Centre, or as it is locally called "Waretown." In 1813 the mills and most of the present village was sold for $4,500.

In 1821 the Ware Mfg. Co. built part of the mills now known as the Charles A. Stevens & Co.'s Woolen Mills. The Ware Co. failed and was succeeded by the Hampshire Mfg. Co. They also failed and sold to the Otis Co. In 1841 Gilbert & Stevens purchased the Woolen mills. In 1851 they dissolved partnership. The town seems to have taken its name from the river passing through it, which bears the same name from its source to its junction with the Chicopee, of which it is the middle and the longest branch. It abounded with fish, the falls being a famous place for taking salmon. Weirs or Wears were constructed to aid in taking them, and hence the name of Ware River, which was afterwards spelled Ware. The present town of Ware is the largest as well as the richest town in Hampshire County. Its present population is about 6,200—about 1,000 of whom are voters. The population has increased 25 per cent. in the last five years, and continues to increase. There are six churches. The town also boasts of a number of handsome public buildings, among which the new Town Hall, erected in 1885, at a cost of over $40,000, takes first place. Another addition to the architectural beauty of the town will be the new $30,000 hotel, now being erected by John H. Storrs. A new Convent School building is also being erected for the benefit of the French Catholic parish.

The building of the Young Men's Library Association is also an ornament to the town.

The Assessors' valuation for 1886 of real and personal estate was $4,000,000.

The largest manufacturing concerns are the Otis Co., employing about 1,450 hands. Their products are checks, denims and cotton underclothing.

The Geo. H. Gilbert Mfg. Co. employ 1000 hands and make white and colored flannels, ladies' dress goods, &c.

Chas. A. Stevens & Co. employ 175 hands and manufacture white flannels.

The Ware River furnishes power to all three companies, but steam power is required in addition during the dry season. The town is lighted by gas,—the electric light being extensively used in the mills. Its adoption as a street light is also probable.

A suitable water supply had become an imperative necessity. Buildings were crowded together, and what were good wells years ago had become fouled with drainage and accumulations of house refuse.

Accordingly in 1885 a committee was appointed and examinations made. Various sources were proposed. Although the country is very hilly, no supply was found at sufficient elevation to deliver the water by gravity. The source finally adopted was a filter or collecting well located in the valley of Muddy Brook, a tributary of Ware River. To decide as to the best location for the well, test wells were driven at eleven different points. The object was to find a locality where the ground was of a coarse, gravelly nature, the interstices of which should be filled with water.

The last of these wells was sunk May 14, and after careful consideration it was decided to locate on the east side of Muddy Brook, about 900 feet from Main street. Four important facts to be considered in connection with the source were, the prospect of a large supply of good water; the absence of anything likely to contaminate the supply; the distance to the point where water takers would begin; and the price of the land.

The first three points were in favor of the locality mentioned.

The location chosen is an open field, part of which is meadows and part upland, in all about 16 acres. It is surrounded on all sides, except where the brook passes through it, by high land, and although near the village is well protected from contamination. About six acres of this high land, where it appeared possible that houses might be built to the injury of the water supply were afterwards taken. Making 22 acres in all.

There seemed to be but little doubt as to the best site for a reservoir. The high land to the north of the village on Church street offered a favorable location, and 4 12-100 acres were bought for that purpose.

The first specifications issued were for cast iron pipe and for laying the same. Proposals were received until noon of June 1, 1886. But one bid for pipe was received, although specifications and blank forms for proposals had been sent to all the principal pipe foundries.

The A. H. McNeal Pipe and Foundry Co. of Burlington, N. J., made the following bid:—

110 tons	12 in.	pipe	at $34.20
48 "	10 "		" 34.70
45 "	8 "		" 35.20
236 "	6 "		" 35.70
40 "	4 "		" 36.70
15 "	special castings,		" 60.70

The amount of pipe used in construction was 624.9 tons of 2240 lbs.

The bids for laying about six miles of pipe and setting all gates and hydrants were as follows:

J. T. Langford, Newton,	$7,000.00
T. F. Maney & Co., Boston,	7,125.50
Francis Leonard, Norwalk, Conn.,	7,246.00
J. J. Newman, Providence, R. I.,	8,892.50
Geo. M. Atkins & Co., Palmer,	8,902.50
Farrington & Springfield, Portsmouth N. H.,	11,428.00
D. W. Devanny, Pittsfield,	12,661.50
John Keogh, Providence, R. I.,	13,996.50

The contract was awarded to Mr. Langford.

The basis upon which the monthly estimates were made up was as follows:—

For laying	12	in. pipe	$0.34
"	10	"	0.29
"	8	"	0.24
"	6	"	0.19
"	4	"	0.14

For rock excavation $3.00 per cubic yard.

Although the price was low, the work was well done.

June 7th proposals were invited for hydrants and gates, and the contract was awarded to the Chapman Valve Mfg. Co. of Indian Orchard.

Their bid in detail was was as follows:—

For	12	in. gates,	$41.02
"	10	"	30.23
"	8	"	19.86
"	6	"	13.38
"	4	"	8.72

For hydrants having 4 in. gate, 2, 2½ in. nozzles, $23.47.

June 18th the following proposals were received for building a distributing reservoir.

Francis Leonard, Norwalk, Conn.,	$9,025.00
F. A Snow, Providence, R. I.,	9,836.25
Geo. M. Atkins, Palmer,	10,715.00
Geo. W. Hendrick, East Hampton,	11,062.50
J. H. Leavitt, Boston,	12,180.00
Keogh & Shaw, Providence, R. I.,	12,023.75
Farrington & Springfield, Portsmouth, N. H.,	13,367.50
Silias H. Munson, Boston,	17,168.75

Mr. Leonard, the lowest bidder, was ill at the time of the opening of the bids, and unable to attend to the signing of the contract. After some delay and correspondence, it was decided to award the contract to Mr. F. A. Snow of Providence, R. I.

On June 22d proposals were received for constructing the collecting well, and also for the pumping machinery.

The specifications for the former called for a price for each foot in depth to which the well should be built.

The following bids were received:

Keogh & Shaw, Providence, R. I.,	$4,300.00
Putterill & Kilian, Boston,	4,902.00
Geo. M. Atkins & Co., Palmer,	5,358.00

E. Haskins, Barre Plains, 5,490.00
F. A. Snow, Providence, R. I., 6,390.00

Messrs. Keogh & Shaw being the lowest bidders, the contract was awarded to them.

The work was performed under the personal supervision of Mr. F. E. Shaw.

Mr. Shaw subsequently took the contract to build a small well or cistern, for the supply of the engine condenser, and furnish and lay 300 feet of 8 in. akron pipe to connect it with Muddy Brook, for the sum of $425.00.

The following bids were received for pumping machinery; and one boiler, complete, and set up:—

Deane Steam Pump Co., Holyoke,—Duplex,

Steam Cylinders.	Water Plunger.	Stroke.	Length.	Diam.	
12 x 22 in.	11 x 18 in.	Boiler 15 ft. x 54 in.		60 3 in. tubes.	

$6,290

Geo. F. Blake, Mfg. Co., Boston, or Knowles Steam Pump Works, Boston, } Duplex,

10 in. x 22 in. x 11 in. x 18 in. Boiler, 16 ft. 2 in. x 54 in. 52 3 in. tubes,

$6,428

Knowles Steam Pump Co.,—Single,

14 in. x 28 in. x 15 in. x 24 in. Boiler, 16 ft. 2 in. x 60 in. 77 3 in. tubes,

$7,280

Davidson Steam Pump Co., Brooklyn, N. Y.,—Single,

18 in. x 34 in. x 16 in. x 24 in. 2 boilers, 16 ft. x 66 in. 102 3 in. tubes,

$7,800

Geo. F. Blake, Mfg. Co.,—Single,

13 in. x 26 in. x 15 in. x 24 in. Boiler, 16 ft. 2 in. x 60 in. 77 3 in. tubes,

$7,900

Knowles Steam Pump Co.,—Duplex,

10 in. x 20 in. x 10¼ in. x 24 in. Boiler, 16 ft. 2 in. x 60 in. 77 3 in. tubes,

Geo. F. Blake Mfg. Co.,—Duplex, $8,280

12 in. x 24 in x 14 in x 18 in. Boiler, 16 ft. 2 in. x 60 in. 77 3 in. tubes,

$8,500

H. R. Worthington, New York,—Duplex,

14 in. x 24½ in. x 12 in. x 18 in. Boiler 16 ft. x 66 in. 84 3½ in. tubes,

$8,800

The Deane Steam Pump Co., increased the size of their boiler to 16 ft. x 60 in. with 80 3 in. tubes and offered to deduct $250 if a foot valve on the suction were omitted and a hot well substituted for a feed water heater. Making their bid on these conditions, $6,040, which was accepted.

Plans and specifications for a brick pumping station, were prepared by Mr. E. N. Boyden, Architect, Boston; and Mr. H. P. Cummings; and Messrs. Aldrich & Hill of Ware, made proposals for furnishing materials and labor.

Messrs. Aldrich & Hill being the lower bidders the contract was awarded to them, at the following prices:—

For the building and chimney, $4,610.35
For the engine foundations which were to be furnished by the town, 460.00
For the coal shed, 489.00

Making a total of $5,559.35

RESERVOIR.

The reservoir is located on land on the west side of Church street, about 4,500 feet from Main street.

The lot as purchased by the Commissioners contains 4 12-100 acres, and cost about $200 per acre. Its very rocky nature is its only objection, but it is difficult to find elevated land in that vicinity which has not this characteristic. The location is very favorable, their being a possibility of water takers the entire distance from the village. Being located, on the opposite side of the village from the supply, so that the water is all pumped through the distributing pipes of the town, is another great advantage, insuring a supply of fresh water every time the pump is started.

The actual work of construction began July 8th, when Mr. Snow with a gang of men commenced removing the brush and light soil from the site of the proposed reservoir.

Mr. Snow's original figures are on the basis of Italian labor. In consideration of a slight advance in the price for earth excavation he agreed to employ all the town laborers, at $1.50 per day, who might apply for work.

After the brush, loose stones and light soil had been removed, the latter to be applied to the top and outside slopes of the bank, the embankments were begun August 6th.

The material proved to be of an excellent character for making a hard and compact bank.

It was spread in layers, six inches thick, wet, and thoroughly rolled with a heavy grooved roller. According to the plans and specifications, there was to be a lining of concrete, 10 inches thick on the inside slopes, and 6 inches on the bottom, and the excavation was made of the proper size to allow for this.

The banks were made entirely of the material excavated, and a much larger quantity of ledge and boulders of all sizes being encountered than was expected, the items of earth and rock excavation were increased somewhat above the estimates.

Much of this stone was passed through the crusher to make broken stone, which was to be placed over the concrete on the side slopes, and a large amount was also used in the slope paving.

A considerable quantity was also used in the construction of the well.

There is still a large amount scattered over the reservoir lot, some of which will probably find its way into cellar walls.

The reservoir, as completed, is 92 ft. 6 in. x 97 ft. 6 in. at the bottom, and 149 ft. 6 in. x 154 ft. 6 in. at the top. The bank is 15 ft. wide on top.

The inside slope is one and a half horizontal to one vertical. The outside slope is two horizontal to one vertical. As before mentioned there is an inside lining of concrete made of one part of cement, two of sand and five of broken stone. The sand and cement were mixed dry, then water enough added to make the mixture of the proper consistency; the broken stone was then added, the whole thoroughly and quickly mixed and placed in position and rammed, till the mortar came to the surface.

The surface was made as smooth as possible and the mass allowed to set.

Various brands of cement were used numerous tests were made to determine their strength at different ages; either as mixed pure, or with various proportions of sand.

When the bank had been carried up to a level of 8 ft. below the top, the cement concrete was carried in horizontally about 11 ft., the thickness being reduced to 6 in. The bank was then built up to a level of 4 ft. 6 in. higher; the process of wetting and rolling continuing. A trench was then excavated to 1 ft. 6 in. wide to the level of the under side of the horizontal layer of concrete, the inside of the trench coming to the back side of the layer of concrete. In this trench was placed clay puddle, thoroughly rammed, making a water tight wall. A tight joint was thus formed with the concrete.

The object of this arrangement is to protect the concrete from the frost, as the reservoir is supposed to be kept full or nearly so, during the cold season. A layer of broken stone 6 in. thick covers the concrete and extends upward to the same level as that of the stone paving. Upon this is carefully laid heavy stone paving 12 in. thick. The stone from the rock excavation, after being squared and trimmed, if required, was used for this purpose.

The stone paving and also the concrete, were carefully laid to line and grade, which was given by means of batter-boards. The paving is carried to within 2.33 ft. of the top, vertically, or 4.19 ft. measured on the slope. This width of about 4 ft. on the slope and about 1 ft. on the top of the bank is of sodding, carefully laid to the same slope as the stone paving.

The lot is of sufficient size to admit of the reservoir being enlarged at some future time; but more frequent pumping would probably accomplish the desired object in a better way. Many towns larger than Ware are provided only with a stand pipe, having a capacity one-fifth that of this reservoir.

The 12 in. inlet, which is also the outlet pipe, when the pump is not running, enters the reservoir below the embankment on the south side. In the same trench is laid the 6 in. waste pipe. To prevent any leakage, and add to the strength of the bank at this point, 3 cut-off walls are built across and around these pipes, the wall starting a short distance below them.

These walls are 18 ft. long and 3 ft. thick. The stone work was laid so as to make as nearly a water tight joint with the pipe as possible. The walls are built somewhat smaller than the trench was excavated, and the space thus left around the wall filled and rammed with clay puddle. The clay was that excavated in building the well.

The cut-off walls were carried up to the level at which the formation of the bank began. The 12 in. inlet pipe enters the reservoir near the middle, and by means of a quarter-bend discharges the water being pumped into it, in a vertical direction. Over the end of the quarter bend is a frame work having two sets of copper wire screens, of quarter inch mesh, which prevent the entrance of leaves into the pipes.

A 12 in. gate is also provided on the force main to shut off the reservoir in case of a leak in that pipe below the reservoir, or when it is desired to pump direct.

The following table shows the quantities and cost of the various items of work.

8,433.5	Cubic yards	earth excavation, at	$0.50	$4,216.75
880.9	"	rock "	1.75	1,541.57
54.4	"	cut off walls,	6.50	353.60
83.3	"	clay puddle,	3.00	249.90
95.5	"	" priming wall,	4.50	429.75
638.5	"	concrete,	6.00	3,831.00
268.1	"	broken stone,	2.50	670.25
1,608.4	Square yds.	stone slope paving,	1.25	2,010.50
355.	"	sodding,	.40	142.00
297.5	Lineal feet,	pipe laying,	.50	148.75
Moving extra soil,				62.50
				$13,656.57

TABLE OF RESERVOIR CAPACITY.

	No. of gallons required to fill reservoir with water at the level of line upon which figures are written.	Gallons to each foot in height.	Per cent. of total capacity.	No. of gallons in reservoir when water is at the level of line upon which the figures are written.	
15 HIGH WATER	0		100	1,557,663	GRADE 292
14	142,800	142,800	.91	1,414.863	
13	279,451	136,651	.82	1,278,212	
12	410,089	130,638	.73	1,147,574	
11	534,847	124,758	.66	1,022,816	
10	653,861	119,014	.58	903,802	
9	767,265	113,404	.51	790,398	
8	875,193	107,928	.44	682,470	
7	977,781	102,588	.38	579,882	
6	1,075,162	97,381	.31	482,501	
5	1,167,472	92,310	.25	390.191	
4	1,254,845	87,373	.19	302,818	
3	1,337,416	82,571	.14	220,247	
2	1,415,320	77,904	.9	142,343	
1	1,488,691	73,371	.4	68,972	
GRADE 277 0	1,557,663	68,972	.0	0	

WATER PIPES.

The force main beginning at the pumping station, is laid through Barnes, Main and Church streets, to the reservoir; a distance of 7,649 feet; of this, 5,973 feet is of 12 inch pipe, while the remainder or 1,676 feet, is of 10 inch pipe. The 10 inch line is supplemented by two 6 inch lines, making it fully equal in capacity to the 12 inch pipe.

Although some difficulty was experienced in obtaining men, the work progressed steadily and on Dec. 15th the last pipe was laid on William street.

The season had closed early and the last work was done at some disadvantage, on account of cold weather and frozen ground.

An attempt was made to lay all pipe uniformly on the north and east sides of the streets and about one-third of the width of the street from the fence line. It is generally considered that the sides of the street mentioned have more sun and that the ground does not freeze as deeply. Some variations have been made from this rule for reasons which seemed sufficient.

The following table shows the length and size of pipe:—

	12 in.	10 in.	8 in.	6 in.	4in.	Total.
Total in feet,	5972.8	1675.7	2256.4	17339.1	6925.5	34169.5
Total in miles,	1.13	0.32	0.43	3.28	1.31	6.47
Per cent.,	17.	5.	7.	51.	20.	100.

In laying this amount of pipe there were 250.3 cubic yards of rock excavation.

TABLE OF WEIGHTS, JOINT ROOM, DEPTH OF LEAD, ETC.

Inside Diameter in Inches.	Class.	Joint Room in Inches.	Depth of Socket in Inches.	Depth of Lead in Inches.	Weight Per Foot. Pounds.
12	A	.5	3.5	2½	70
12	B	.5	3.5	2½	77
12	C	.5	3.5	2¼	85
10	A	.5	3.5	2½	62
10	B	.5	3.5	2¼	67
8		.4	3.0	2	45
6	A	.4	3.0	2	31
6	B	.4	3.0	2	33
4		.4	3.0	2	20

The cost of pipe, pipe laying, rock excavation, hydrants, gates, and gate boxes included within contract was $31,446.27, and the length so laid about 5 9-10 miles, making an average of about $5,330 per mile.

COLLECTING WELL.

Work was commenced July 20. By means of 2 inch sheet piling, kept in place by circular ribs, made of two thicknesses of 3 inch plank, an excavation 41 feet in diameter and 23 feet deep was made.

Within this excavation the walls of the well were built. The lower portion, or footing course, was of heavy stone 5 feet 6 inches thick and 3 feet high. At this level an offset of 1 foot 4 inches was made, upon which rested the brick lining, one foot in thickness.

The brick work is 25 feet in diameter at the bottom and 26 feet at the top. The stone work is two feet thick at the top, and over both stone and brick work is laid a granite capping course one foot thick and three feet wide, binding the stone and brick work together. The site was that of an old brick yard. After going through 10 to 12 feet of clay a porous gravel was reached and water in considerable quantity was obtained. Continuous pumping was required to keep the excavation clear for the workmen. The water was pumped by a Webber centrifugal pump, having a 6 inch suction and 5 inch discharge. It was run by an engine having a 10 inch cylinder and 12 inch stroke, making about 175 to 180 revolutions per minute. The water after being pumped out was made to pass over the weir and careful measurements showed a flow of between 600,000 and 700,000 gals. in 24 hours; and this, during the dryest part of the season. The stone used were of large size, from the reservoir lot, and from adjoining land.

The contract for building the small cistern or well, previously alluded to, together with furnishing and laying about 300 feet of 8 inch akron drain pipe, connecting it with Muddy Brook, was awarded to Mr. F. E. Shaw. The purpose of this cistern is to supply the condenser of the pumping engine.

There is a box made of 2 inch chestnut plank, about 12 feet from the brook placed in a gap of the pipe line, but connected with it. In this box are placed 2 copper wire screens, one or both of which can be replaced by stop plank in case it is desired to shut off the brook from the cistern. A 6 inch branch from the 8 inch pipe, on which is a six inch gate, allows the brook water to be turned into the collecting well, in case of extreme drouth, if it should be found necessary, which is not anticipated.

It is believed that the present supply is sufficient for a number of years at least, and when more water is needed, another well a few hundred feet distant, can be constructed at a comparatively small cost.

The water is of the best quality, clear and cold. It has an equable temperature of 48 or 49 degrees throughout the year. The temperature of Muddy Brook April 29, 1886, was 57 degrees and that of the water in a spring near the present well was 49 degrees. January 1, 1887, the brook water was 34 degrees and the well water 48 degrees. Between these dates the brook water reached a temperature of 80 degrees, while the well water remained almost constant.

High water in the well is about two feet above that of the brook.

SERVICE PIPE.

Much thought and attention were given to the choice of material for the service pipes. Lead is no doubt the most durable, and would perhaps be the cheapest in the end. There is, however, a slight prejudice against it, although there is probably but little ground for it.

The result of correspondence with other towns and the examination of samples of various kinds of pipe which had been in use some years led to the adoption of plain wrought iron pipe, 1 inch in diameter, lined with pure cement $\frac{1}{8}$ of an inch thick, reducing the diameter of the pipe to $\frac{3}{4}$ of an inch, which was the usual size. When necessary a larger size was used.

The cement is not to add strength to the pipe (although some samples of the cement used were recently tested and stood a strain of over 250 pounds per square inch) but to protect it from contact with water and the consequent action of rust. Plain iron pipe is soon filled with rust, and even the tar coating or pitch varnish, applied to wrought iron pipe and used in many places, does not protect it for more than perhaps 8 or 9 years. The pitch varnish or coating applied to cast iron pipe has proved to be a great protection, and all water pipes are now treated with this preparation. The same process applied to wrought iron pipe is not so effective, owing to the different character of the two forms of iron. The cement lining can be cheaply and quickly done, and it is believed that the service pipe adopted will be satisfactory. The lining was done by day labor by the town and the pipe laid by contract by J. T. Langford at 20 cents per foot.

The service pipes were laid from the mains to the inside of the cellar walls, but individuals were charged only from the street line.

PUMPING STATION.

The pumping station consists of a brick building with an engine-room, boiler-room, coal-shed and chimney. The engine-room is 29 feet 10 inches x 27 feet 8 inches inside. The boiler-room is 26 x 35 feet inside and the coal-room 17 x 35 feet and 8-feet high. The latter is located in the rear of the boiler-room and connects directly with it. It has a capacity of about 100 tons of coal.

The chimney is 80 feet high and 8 feet square at the base.

The ground sloped up from the rear of the boiler room to a level about 8 feet higher. An excavation was made into this slope and stone walls about 4 feet thick form the walls on three sides, the fourth being the rear brick wall of the boiler room, which is 20 inches thick to the height of the coal room roof. Coal carts can be backed to the edge of the roof and the coal dumped through large scuttles directly into it.

The walls of the engine-room are 14 inches thick with a 2 inch air space. Those of the boiler-room are 12 inches thick and solid. The brick work of the interior of the engine-room and the outside of the entire building and chimney is laid in red mortar. The inside of the boiler-room is in white mortar and whitewashed. The wood-work of the engine-room is of white wood stained cherry-color. The floor is of rift pine. The window sills and caps are of freestone. The building and chimney have a granite base, and the latter has in addition two belt courses of the same material.

The boiler was built by Wm. Allen & Sons, Worcester, and is insured by the Hartford Steam Boiler and Inspection Company for one year. It is provided with an automatic damper regulator. The pipe from the safety valve extends to the outside of the building.

The air pump or independent condenser has an 8 inch steam cylinder, 10 inch water plunger, all of 12 inch stroke. It is arranged to draw water from either the collecting well or the well supplied from the brook. As the amount used is considerable it will ordinarily be taken from the latter source. It can also be supplied from the force main.

The drip well is of brick, just outside the building, into which the condensing water and that from the various drip pipes from the pumps is discharged. A line of 8 inch drain pipe carries the waste water to the meadow below the collecting well, from whence it flows to the brook.

A feed pump for supplying the boiler, draws water from a hot well, filled with warm water from the condenser. Water for the boiler can also be taken from the collecting well, or directly from the force main.

The 4 inch suction pipes for the condenser, in either well are provided with five inch foot valves. The 2 inch suction pipe for the force pump has also a three inch foot valve. The suction for the pumping engine is of 14 in. cast iron flanged pipe without a foot valve. A Y branch on the 4 inch suction to the collecting well, makes the connection with the small or condenser well. A 4 inch valve is placed between the branch and each well.

The ground about the well being of a clayey nature, not suited to sustain the heavy weight of buildings, pumping machinery, and chimney, the pumping station was located a short distance to the east, on soil composed entirely of gravel.

The engine room is supplied with a mercury column having a float, to which is attached a brass rod having an adjustable index. This index moves over a sectional plan of the reservoir drawn to the proper scale, so figured as to show at a glance the amount of water in the reservoir and the number of gallons required to fill it.

As mercury is about 13.6 times heavier than water, it requires a column of mercury about 16.2 feet high to balance the water pressure at the pumping station, the floor of which is 216 feet below high water in the reservoir. The pipe containing the mercury is somewhat longer, to allow for the added pressure due to friction when pumping, which is about 4 lbs. and for water hammer.

One foot of water in the reservoir is shown by a space of about seven-eighths of an inch on the plan.

To show the height of water in the well, a 1 inch iron pipe was laid just below the surface of the ground, entering the well just below the capping stone and the basement of the engine-room just below the granite base. In this pipe was placed a wire of brass picture cord. In the well the wire passes over a pulley and is attached to a copper float. In the basement, the wire runs over a pulley, up through the floor and over a second pulley fastened to the wall of the engine-room near the ceiling, then down and through a pulley supporting a lead weight or counter-balance. The wire is then carried up and fastened just below the upper pulley. To the lead weight is attached an index which extends across it, and moves over a figured scale on either side. One scale shows the distance of the water surface below the centre of the water pressure gauge and the other how far the water is below the top of the brick work of the well.

The space moved over by the index is only half that moved over by the float. The marks on the scale corresponding to feet in the well are therefore, but 6 inches apart.

This indicator enables the engineer to see at what height the water stands in the well at any time, and gives him the necessary figures to add to the reading of the water pressure gauge to obtain the total lift, which of course includes friction and suction.

A check valve is placed on the 12 inch discharge pipe or force main, in a brick chamber just outside the building.

Both the well and pumping station have a slated roof, the coal-shed one of tin.

Top of 6 inch iron pipe into collecting well, from brook,	64.71
Engine-room floor,	76.08
Centre of water pressure gauge,	82.08
Top of wooden railing in well,	78.59
High water in reservoir,	292.00
Top of reservoir banks,	296.00

ENGINE DUTY TEST.

On January 7, 1887, an informal test of the pumping machinery was made. The fire from the previous day's pumping was partially kept up and at 10 o'clock A. M. the test began and continued to 5 o'clock P. M., or seven hours.

Observations were taken every fifteen minutes of the counter, steam pressure, length of stroke, height of water in the well, water pressure and vacuum.

The coal was weighed in barrow loads of three hundred pounds and the firing done under the direction of Mr. Hayes of the Deane Steam Pump Co. The records were taken in connection with Mr. Newcomb, representing the same company.

The following data were used in calculating the duty. Length of test, 7 hours.

1,929½ lbs. of bituminous coal consumed.

Area of 11 inch plunger,	95.033 sq. in
½ area of 3¾ inch plunger rod,	2.970 sq. in.
Effective area,	92.063 sq. in.
Average length of stroke,	18.91 in.
Average lift above centre of pressure gauge,	220.62 feet,
Average distance from centre of pressure gauge to surface of water in well,	23.24 feet.
Total lift including friction and suction,	243.86 feet.

One U. S. gallon contains 231 cubic inches

Number of Revolutions, 15,237.

Number of stokes, 60,948.

$$\frac{92.06 \times 18.91}{231} = 7.536 \text{ gallons displaced at each stroke.}$$

$$\frac{7.536 \times 8.338 \times 60{,}948 \times 243.86 \times 100}{1{,}929.5} = 48{,}401{,}282$$

Coal. Foot lbs.

The total quantity of water pumped was:—

7.536 x 60,948=459,304 gallons.

The average number of gallons per hour was:—

$$\frac{459,304}{7} = 65,612$$

The specifications called for a duty on the basis of plunger displacement. As the water pumped could not be accurately measured, no exact estimates of the amount of slip could be made. The height of water in the reservoir at the beginning and end of the test was carefully taken and from a calculation from these data and an allowance for the water being used by consumers and that running in the watering trough, it appeared that the slip was only a small per cent.

The specifications called for a capacity of 1,500,000 gallons in 24 hours, or 62,500 gallons per hour. The Deane Pump Company guaranteed a duty of 45,000,000 foot lbs. per 100 lbs. of coal. It will be seen that this guarantee was exceeded and that more than the required amount of water per hour was pumped. The coal used was the ordinary soft coal that had been used for pumping, and no allowance was made for ashes or clinkers. The fires at the close of the test and the height of water in the boiler were as nearly as possible the same as at the beginning.

In 1880 Ware had a population of 4,817. In 1885, 6,003, an increase of 1,186, or 25 per cent. in five years. With added railroad facilities and the various kinds of business which are so well established, the town will continue to grow.

The present bonded water debt consists of $58,000 at 3½ per cent., and $15,000 at 4 per cent.

DISCUSSION.

The Chairman. Gentlemen, Mr. Fuller's paper is now before you for discussion.

Mr. Fitz Gerald. Is this guage shut off when you are pumping?

Mr. Fuller. No, but it can be shut off if necessary. There are forty pounds of mercury, which cost about 50 cents a pound, making a cost of $20, and that is really about all the expense there is. Of course, it is not as satisfactory as some sort of an electrical indicator, perhaps, but it is very much cheaper. Anyone can make it. By knowing what the height of your water is, and making this to a scale and setting your index accordingly, you can tell approximately where the water is in the reservoir. While the water is being pumped, of course, the added friction will lift up this index, probably, above what the water would be, but the engineer, when he stops pumping or by slowing down, can tell pretty nearly where he is.

Mr. Fitz Gerald. Doesn't it jump up and down?

Mr. Fuller. Yes, there is some oscilation. You can't do very much with it when you are pumping, because, as I say, the added friction will lift this up.

Mr. Billings. What advantage does your guage have over an ordinary pressure guage?

Mr. Fuller. I think you can tell rather nearer than you can with a pressure guage. You have this space of five-eighths of an inch which represents

The rolls of blue prints contained sketches upon the following subjects:

1. Mains and Connections at Pumping Station.
2. Mains and Connections at Distributing Reservoir, by R. C. P. Coggeshall.
3. Vise for making Cup-joint, A. B. Drake.
4. Blower and Lamp, H. W. Rogers.
5. General Plan of Works.
6. Reservoir Dams.
7. Diagram of Consumption, Edwin Darling.
8. General Plan of Marlboro Works, George H. Stacey.
9. Service Box, Willard Kent.
10. Water Tank, W. F. Codd.
11. Temporary Weir, William B. Sherman.
12. Automatic Air Valve, M. M. Tidd.
13. Watering-Cart Hydrants, W. H. Richards.
14. Dams and Embankments, W. H. Richards.
15. High Service Motor, F. H. Parker.
16. Meter Attachment for Watering-Carts, National Meter Company.

a pound, whereas with a pressure guage, I don't know, but the largest, I think, wouldn't have more than a quarter of an inch to represent a pound.

Mr. Fitz Gerald. What was the total cost of your works ?

Mr. Fuller. The total cost on the first of January was $72,497. That included quite a large amount of service pipe and material which was on hand, so that the cost since then has been mostly the labor of putting it in, and, also, the labor and cost of making a short extension of six-inch pipe. I suppose the whole cost is less than $75,000.

Mr. Fitz Gerald. What is the yield of water, the capacity ?

Mr. Fuller. Between 600,000 and 700,000 gallons in a dry time. I suppose at present, with 229 services, they are using, perhaps, 90,000 gallons a day. If they pump, as they have done once or twice for various purposes, every day, the water will be drawn down, perhaps, 10, or 12, or 15 feet, but it soon fills up again.

DISTRIBUTION OF SKETCHES.

Mr. Sherman. If it is your pleasure we will distribute the sketches at this time, because Mr. Parker is about to read a paper, and the members will find in their rolls a blue print of the motor of which Mr. Parker is to speak.

The Chairman. The next business in order is the reading of a paper by F. H. Parker, Supt., Burlington, Vt.

HIGH SERVICE MOTOR.

BURLINGTON CITY WATER WORKS

BY

F. H. Parker, C. E., Superintendent.

The City of Burlington, Vermont, is built upon a side hill, sloping towards the west towards Lake Champlain, from which its water supply is pumped. The reservoir is located two hundred and eighty-nine feet above the lake, upon the crest of this hill, but not upon its summit. Two lines of ten inch pipes lead away from the pumps to the reservoir, and connect with the general system of mains at all intersecting streets, so that, we pump into and distribute from the same mains.

In 1868, when the works were built, there were very few residences upon the summit of the hill, but in 1879 their number had so increased, and several public institutions having been erected, the necessity for a high service water supply was conceded, and the matter was referred to the Superintendent, A. Torrey, C. E., for investigation and report. Mr. Torrey reported, "that to obtain a supply by operating pumps at the reservoir, wind power was too unreliable, steam power too expensive, and to raise the water consumed by the city sixty to eighty feet higher, by means of the pumps at the lake, seemed to call for so large an outlay and yearly expense, as to be classed among the last resources ; but suggested that some sort of a hydraulic motor might be placed in the ten inch main in the reservoir lot, that would be worked by the water passing to and from the reservoir, and thus furnish the power for working a pump to supply the higher service."

On taking charge of the water works, in the summer of 1880, this report was referred to the writer, with the request that the above plan be carried out at once. The necessary pipe was purchased, a contract was made for a tank, but where to obtain a motor to work under the conditions imposed, was a question. The conditions were as follows, the pressure of water to work a motor in that position would vary from two and a half to five pounds per square inch, while the pressure against the pump, with a full tank, would be thirty-six pounds per square inch. The motor would be in the line of main pipe, and must work with very slight friction, and without shock ; it must operate by water passing to or from the reservoir ; it must offer no resistance, in either direction. to a supply of water, of the full capacity of the main, at all times when needed ; it must waste no water ; and must be practically automatic in its action.

So far as could be learned, nothing of the kind was in use in this country. Correspondence with English engineers afforded the information that a similar use of water from a reservoir, was made in Brighton, but the motor used was similar in construction to a direct acting piston pump, and worked under a pressure of forty to fifty pounds.

The motor which was adopted, a description of which is now presented to you, was designed and built by W. H. Lang, a builder of pumps in our city under the guarantee that if it did not satisfactorily perform its duty there should be no charge.

The cylinder to the motor, marked M. C. on plan, is eighteen inches in diameter, and sixty-four inches long. It is located in the line of ten inch pipe leading into the reservoir, and connected with it on each side by twelve inch Y branches, which are still farther enlarged near the gates, G. Within this cylinder, working in a brass bushing, is a hollow air tight piston, fifteen inches in diameter and thirty-two inches long, which is acted upon and makes a thirty-inch stroke, moved by water passing to or from the reservoir.

To the end, C, of the motor cylinder is attached a plain piston pump marked P, the cylinder of which is ten inches in diameter and forty inches long, and within which works a piston four and three eighths inches in diameter, making the same stroke as the motor, being connected to one end of the piston rod of the motor, which passes through cup leather packing in the head C. The suction valves are on the right of the pump ; the discharge valves, on the left.

The supply of water to the motor cylinder is controlled by four circular brass gates, twelve inches in diameter, marked G. that turn like butterfly valves, on vertical stems of phosphor bronze, working in stuffing boxes, and operated by the wrist plate, W. The motion of the wrist plate is obtained by the action of a four-inch piston in the shifting cylinder S, that is driven by water from the higher service. The valves that control the motion of this piston are moved by the rod T T, which is connected at each end with tappets, that work through stuffing boxes through each cylinder head, and are driven out first at one end, and then at the other, as they are struck by the motor piston as it completes its stroke.

The motor as shown in plan is working by water from the pumps, the piston moving towards the end C of the cylinder, and driven by water enter-

ing the upper left hand gate G, the water in front of the piston passing to the reservoir by the lower right hand gate. As soon as the piston reaches the end of its stroke at C, it drives out the tappet at that end of the cylinder ; this reverses the valves of the shifting cylinder S, forces out its piston, which moves the four gates by the wrist plate W. Water will then enter the motor cylinder by the lower left hand gate, and leave by the upper right hand gate ; the motor piston will move towards M, drive out the tappet at that end, which will, by the aid of the piston of the shifting cylinder, set the gates as shown, and the motion will be repeated.

If the motor when worked by the pumps should stop, from anything getting into it or from any part breaking, the water would pass to the reservoir by the bye pass under the motor, by raising the inclined check valve I, and without appreciably raising the pressure.

When the pumps are idle, and the motor is working from water passing from the reservoir to the city, the action of the gates requires reversing. This is effected by aid of the diaphragm D, and reversing cylinder R shown in elevation, but purposely omitted on the plan. The supply of water to operate the piston and valves of the shifting cylinder S, is taken through the reversing cylinder R, through a pipe E from the high service side of pump, and discharged after throwing the gates, through the pipe X, into the pipe on the low service side of the pump The position of the piston in the small reversing cylinder R, determines at which port the water leaves this cylinder, and the piston is moved by being attached to a rubber diaphragm D, which is raised or depressed. by the pressure exerted upon it through the connecting pipes shown.

When the motor is worked by the pumps the pressure upon that side is the greater, and the diaphragm is depressed ; as soon as the pumps stop the pressure becomes greater on the reservoir side, and the diaphragm is raised; this raises the piston in the reversing cylinder, and what was the supply pipe to the shifting cylinder becomes the exhaust, and what was the exhaust becomes the supply. The action of the gates is thus reversed, and the motor starts working again, by the water leaving the reservoir.

When a greater supply of water is demanded from the reservoir, than can pass through the motor, it is obtained by aid of the vacuum cylinder V. This cylinder is fitted with a piston, whose normal position is at the top of the cylinder ; a rod connecting with it passes out through a stuffing box, and is connected by a small chain with the lever L of the check valve I. A pipe B connects the bottom or this cylinder, with the main pipe below the motor, while the pipe H connects the top of the cylinder with the main above the motor. In the pipe H is a stop-cock, the weighted lever to which is supported by a piece of copper wire, that forms the bottom of a small stirrup, that hangs by the side of the piston rod of the vacuum cylinder V, and a bolt in this rod rests on top of the weighted lever. Any failure of supply is obviated in this way, as soon as the demand exceeds the supply, a partial vacuum occurs below the motor, and a suction is created through the pipe B, which pulls down on the piston of the cylinder V ; as soon as the piston begins to move down, it shears the copper wire holding up the lever to the

stop-cock in pipe H, which allows the lever to drop, opening the stop-cock, and letting in a stream of water upon the top of the piston to assist the vacuum below. This makes the downward movement of the piston surer, steadier and faster, and draws on the chain attached to the lever L, which opens wide the inclined check I, and holds it open until the attendant closes it, and allows the motor to start again.

The pump worked by this motor delivers water through nearly a mile of pipe, to a tank of one hundred and six thousand gallons capacity, and a four inch overflow pipe returns from the top of the tank, to the main pipe, between the motor and reservoir, so that no water is wasted, even if the tank overflows.

The motor when working at its maximum speed, will pass theoretically, in twenty-four hours, seven hundred and fifteen thousand gallons, and the pump, at the same time, will deliver theoretically, fifty thousand gallons, in addition to what is used in the shifting cylinder. The actual quantity delivered is considerably less, for no such amount of water passes through the motor in that time, as our average pumping last year was only six hundred and twenty-two thousand gallons per day, and a large part of this amount was used, before reaching the reservoir. We arrange our hours of pumping at different seasons, so as to only work the motor sufficiently to keep the tank full.

This motor is presented to your attention simply, as a machine embodying in its construction an exceedingly ingenious and novel application of well-known mechanical principles, that has for six years, under very trying conditions, successfully, economically and almost automatically accomplished its work.

DISCUSSION.

The Chairman Mr. Parker's paper is now before you for discussion.

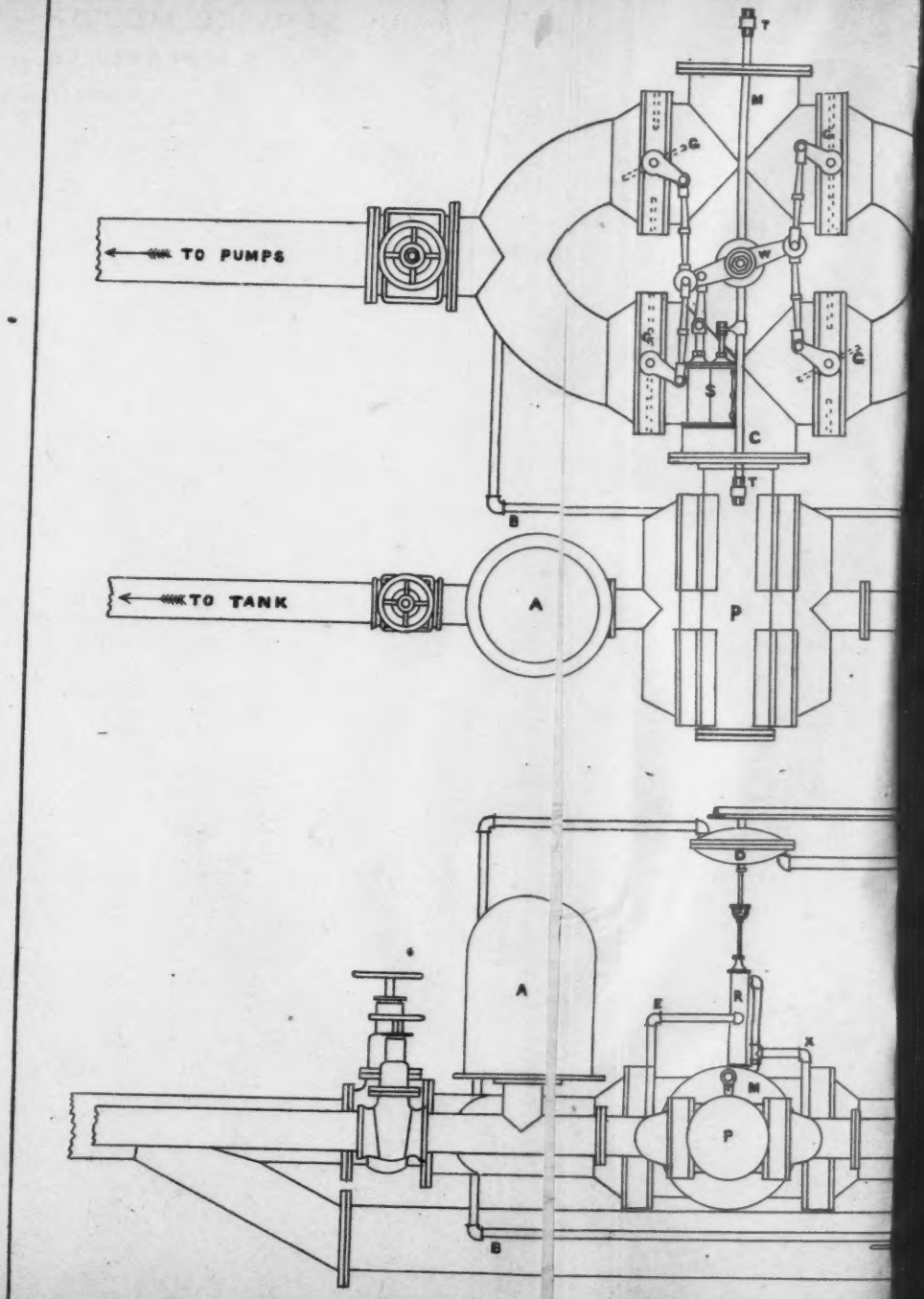
Mr. Fuller. I would ask Mr. Parker if he can tell what the average power of the piston is.

Mr. Parker. I cannot give you any exact information in regard to that. We never have made any tests. The motor has always done its work perfectly satisfactorily ; it has furnished an ample supply and we have never made any tests to find out accurately what it would do. Of course, there is a certain amount of slip by these gates. The gates have no exact seat. They turn, as I say, like a pivotal valve, and, of course, while they are being reversed the current of water is changed, first from the gate on the right to the gate on the left, and there is a certain point where all four of the gates are open at the same time. That is for a very short interval of time, but a certain amount of water must pass. As near as I can figure, the amount of water that is consumed on the entire service will not vary far from an average of 15,000 gallons per day. In the summer time it is greater than that, but in the winter, possibly, it is some less.

Mr. FitzGerald. Did you state the cost of this machine?

Mr. Parker. No, I did not; the cost was $1,900 and forty odd cents.

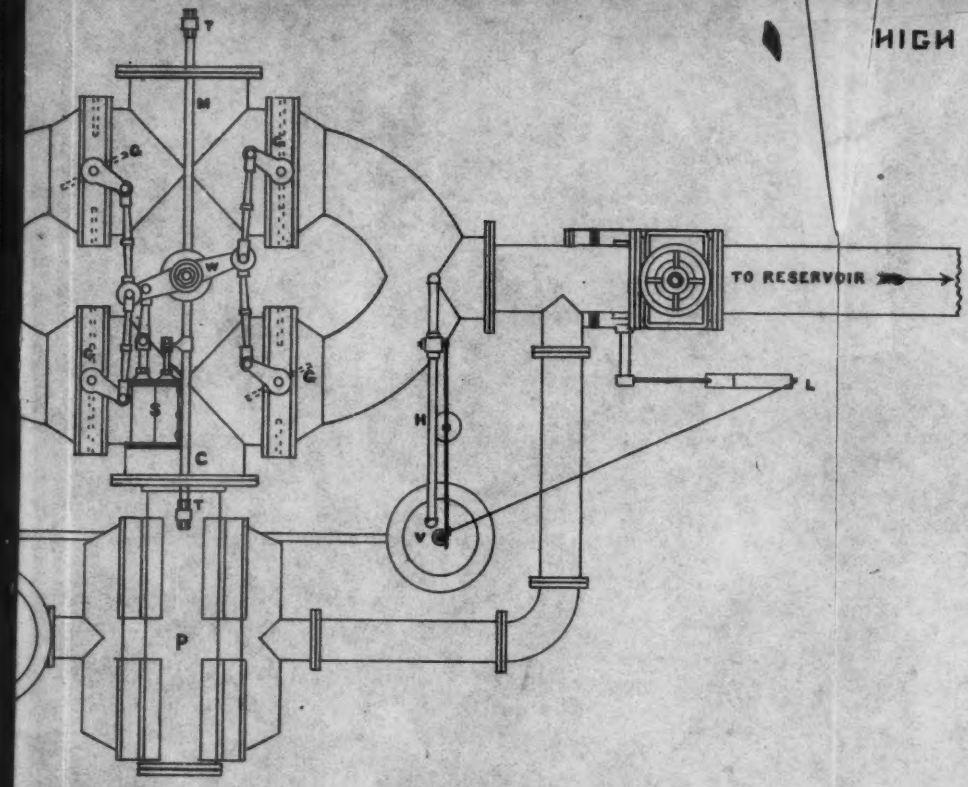
Mr. FitzGerald. What is the pressure on the receiving end?

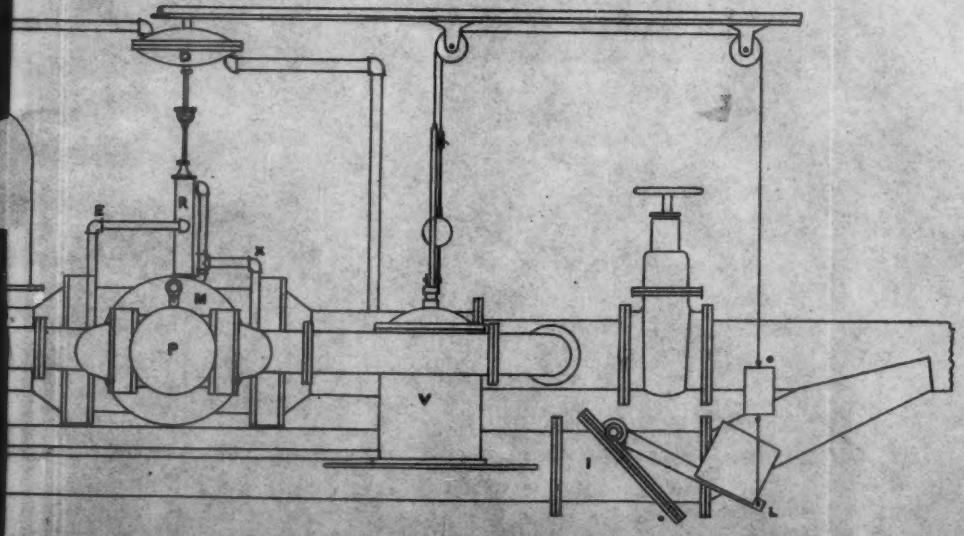

T
M
G
W
S
C
T
B
TO PUMPS
TO TANK
A
P
D
A
E
R
X
M
P
B

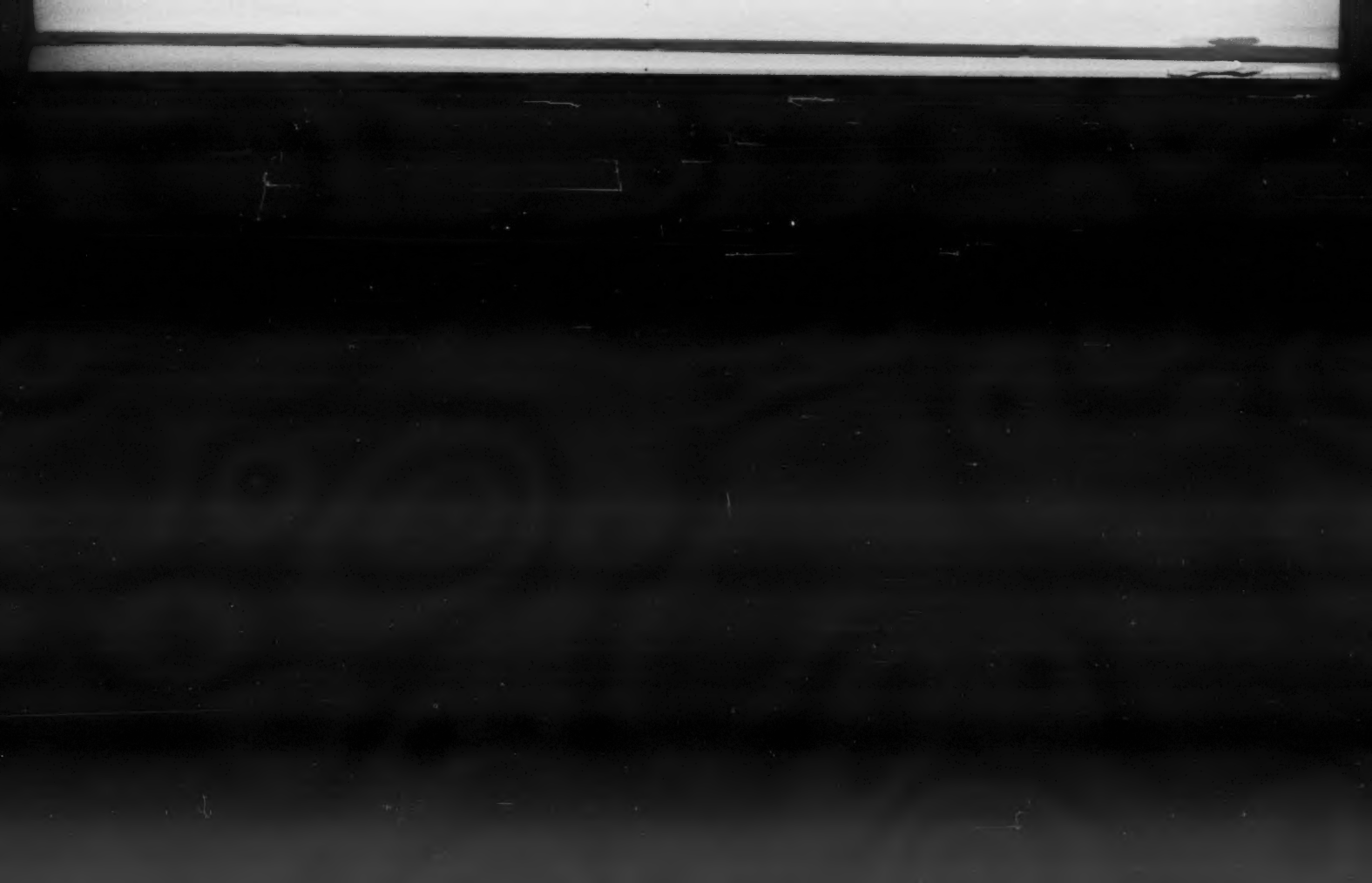
HIGH SERVICE MOTOR

F. H. PARKER Supt.

BURLINGTON Vt.







Mr. Parker. When the reservoir is full the head is between 12 and 13 feet, and the pressure is slightly over five pounds. Of course when the pumps are not working it absorbs a corresponding amount of pressure.

Mr. FitzGerald. It is very near the surface of the reservoir?

Mr. Parker. Yes, sir.

Mr. FitzGerald. How much higher does it lift the water?

Mr. Prarker. The back pressure is 37 pounds, that will raise it 60 feet. I stated that the water is delivered from a tank through something over a mile of pipe. That does not include the whole service but simply from the motor to the tank.

Mr. FitzGerald. This pipe is not tapped?

Mr. Parker. Yes, it is tapped all the way along.

Mr. FitzGerald. How much attention does this motor require.

Mr. Parker. When it was first put in we gave it but very little attention, just looked at it occasionally; but I have now made arrangements with a machinist to look after it and keep it in repair, and we pay him $300 a year. He takes the motor and pump apart twice a year, cleans the suction valves and takes out the accumulations that may take place there, and keeps it in thorough repair. He has a sounder connected with his house, so that morning, noon and night, when he is at home he gets the stroke and can tell whether or not the motor is running all right. He has got it down so fine he can tell simply by listening to the stroke, so it is not necessary for him to visit more than once in two or three days.

Mr. FitzGerald. How many services are there on this?

Mr. Parker. I think about 60. There is another point about this motor. If it was working on a line which was supplying the reservoir by gravity, where it would have a regular stroke to make, a certain amount of water passing through every twenty-four hours, you can see it would work much more satisfactory, or, at least, there would probably be much less wear and it would not require so much attention. Now, through the night with the pumps not working, it will make, perhaps, five or six strokes a minute, and then in the day time, with the varied consumption we have, it will be running, say, twenty-two strokes a minute. It has to regulate itself to all these changes, and, of course, it gives it a much more severe test than it would have if it were on a direct pumping main, or if it were served by a gravity supply.

Mr. Fuller. How much space does this occupy?

Mr. Parker. I think the building measures 20 feet square.

Mr. Fuller. Is there a house built over it?

Mr. Parker. There is now.

Mr. FitzGerald. It seems to me that this device is applicable to a great many water works where the supply is comparatively small and where there are few houses situated above the ordinary level of the reservoir. I should like to know if there is anything like it in this country, or any other motor in this country, especially here in New England? I have seen such devices on the other side of the water, but I never have heard of one here. Does Mr. Parker know of any?

Mr. Parker. I do not.

Mr. Billings. Is it fair to say it takes about 15 gallons through the motor to get one gallon into the high service tank?

Mr. Parker. I didn't figure it in that way. The capacity of the motor is 17,500 gallons.

Mr. Richards. I would like to ask Mr. Parker if he has ever made any experiments as to the pressure?

Mr. Parker. Yes, we have a pressure gauge connected with the motor, with connections both above and below. The pressure varies from two and a half to five pounds, according as the reservoir is full or down. When the pumps are working it will add that amount of pressure to the mains throughout the city. The pressure varies 10 pounds according as the pumps are working or the motor is working when the pumps are not.

The Chairman. In answer to Mr. FitzGerald's question, I will say that the firm of Henry R. Worthington build a motor which can be used for the purpose of utilizing waste water from a reservoir and pumping to a tank. That would work under some conditions, but the conditions in this case seem to be very peculiar.

Mr. Parker. In talking with Mr. Lang, who designed this motor, he said that if the pressure had been great enough to work it, it would have simplified the construction very much. But the pressure was not great enough to throw the valves. If he could have had 40 or 50 pounds pressure, he could then have thrown his gates by direct pressure and none of this shifting device for throwing them would have been required. But here the pressure was so slight it would not throw the gates quick enough, and consequently, he had to resort to the pressure from the higher service, with the arrangement for shifting.

The Chairman. If there is nothing more to be said on the subject of Mr. Parker's paper, you will give your attention to Mr. James H. Hathaway, Water Registrar, New Bedford, Mass.

SOME REMARKS ON METHODS OF COLLECTING WATER RATES.

After long and serious study of the subject assigned to me for this occasion, I am still undecided what to say or how best it should be treated to make it of interest to you: I have searched the records and reports of my department from the commencement of our Water Works to the present time, still very little could I find in reference to "Methods of Collecting Water Rates."

Under Chap. 17, Sec. 9, of the Ordinances of New Bedford, the Water Registrar is given charge, under the direction of the Board, of all matters connected with the delivery of the water and the payment therefor; he is to see that all rules and regulations of the Board or of the City Council in relation to the use of the water are observed, and all the penalties for their violation enforced, &c.

Chap. 38, Sec. 4, reads as follows:—"All assessments of water rates for a year, or a fraction of a year, shall be payable in advance; and in all cases when the consumption of water is ascertained by meter, gauge or estimate of the Water Board, the bills shall be rendered quarterly; and such bills shall be paid within ten days thereafter."

Sec. 6 of the Regulations of our Water Board is as follows:—"The annual rent for the use of the water shall be payable in advance, on the first day of July of each year. All charges for specific supplies, or for fractional parts of the year, shall be payable in advance and before the water is let on."

Sec. 19, of Chap. 17, Requires that all regulations referring to the taking of water be printed upon every bill for water rent. All bills due on the 1st of July of each year must be paid on or before July 16th, or the supply must be cut off.

I have quoted the foregoing to show how very lightly our law makers regarded methods of collecting water rates. In one instance reference is made to collections to be made quarterly and in another to bills due yearly. The Registrar is then left to gather in the revenue as he deems proper —backed with the right, of course, to cut off the supply of water if bills are not paid within a specified time.

The methods to be adopted in all cases should be, in my opinion, as simple as possible,—deeming it quite necessary that an inspection be kept up through the whole year,—bills should be made out and collected by the Water Registrar, and in no case should he be required to place them in the hands of the Treasurer or Collector of taxes for collection. Water takers should be required to call upon the Registrar and make payment, not the Registrar upon the water takers for payment and if bills for rates are not paid within the time prescribed by law he should be allowed to cut off the supply of water without further notice.

My own methods in New Bedford are very similar to those to which I refer and I take the liberty to recommend them because I have given them a long trial with good results.

We have a population of nearly 36,000, of that number nearly 29,000 are supplied with water at their dwellings. On the 1st of July last I sent out about 6,500 water bills, on the 17th of July, when the list was taken off, there were only 150 delinquents and by the first of August about one-half had paid up together with the usual fine of $2, and the other half were deprived of their water supply. That I call a very good showing.

It was my intention to call your attention to many of the trials incident to the collection of water rates. I was going to tell you of the man "who don't use much water" on account of a small family, and of the man who had a good well of water, but friend Darling took the wind out of my sails in that direction last evening.

In conclusion I want to say that in New Bedford we have but 76 meters, 12 on motors, 41 house meters, 11 wharf meters, and 12 in manufacturing establishments. This must be quite encouraging to our meter friends present.

The Water Registrar of Manchester, Mr. Stearns, has requested me to call your attention to the yearly reports of the various cities and towns. He sends out about 300 and receives but a very few in return. Would it not be well for each one to have a list at home and forward to all?

DISCUSSION.

The Chairman. Are there any questions to be asked or remarks to be made on the subject of Mr. Hathaway's paper? The subject is very im-

portant, one of the most important, perhaps, in connection with water works.

Mr. Babcock. I understand that your rates are all in advance?

Mr. Hathaway. Yes, sir; except the meter rates.

Mr. Babcock. What are the meter rates? I didn't understand that you gave those.

Mr. Hathaway. The meter rates for manufactories are 2½ cents a thousand gallons. If we put a meter into a dwelling house we charge $5, and beyond that the charge is 15 cents per 1000 gallons. We charge $2.50 for the first rate, $2.50 for a bath-tub, and $2.50 for a water closet. There are stable rates besides that.

Mr. FitzGerald. How many services are there in New Bedford?

Mr. Hathaway. There are now 5,560.

Mr. FitzGerald. How many of those are metered?

Mr. Hathaway. Only 41. There are 76 meters in all, but only 41 for dwelling houses; the others are for manufacturing establishments and for motors.

Mr. Babcock. Does the city furnish the meters?

Mr. Hathaway. We furnish them for a price. We meter manufactories without charge, but not dwelling houses.

The Chairman. How rigidly is your rule about shutting off the water for non-payment of rates enforced?

Mr. Hathaway. Last year I turned off the water just as soon as I could get my list out. I did it the second day after the fifteenth of July; the afternoon of the seventeenth and the eighteeth I began to turn off the water without further notice. I generally put a notice in the paper when I issue the bills, saying that if the rates are not paid on or before the sixteenth the water will be shut off; and just as soon as we can get a list we start out. I shut off nearly 150 last year. There were a few who came in before we got to them, but we shut off nearly all we had on the list, and some of them haven't been turned on yet.

Mr. FitzGerald. What is the consumption per capita in New Bedford?

Mr. Coggeshall. About 120 gallons.

Mr. Beals. Have you any figures as to what it costs you for water per 1000 gallons?

Mr. Coggeshall. The full details are in the report, I can't carry them in my head.

Mr. Beals. Have you the approximate figures in your mind now?

Mr. Coggeshall. I do not like to state them from memory.

Mr. Beals. It costs more than 2½ cents?

Mr. Coggeshall. Yes, sir; it costs nearer 10 cents; I think it is somewhere between 9 and 10 cents.

In reply to a question by a member Mr. Brackett said: As regards the amount of water used for fires, I think it would be insignificant, from the fact that the amount used in Boston for two or three years past, based upon the actual time that the fire streams were in use, of which we have kept a record, is only about 5,000,000 gallons per annum, which is about one-sixth of one day's consumption.

Mr. Fuller. That amount is estimated, I suppose?

Mr. Brackett. To a certain extent. They keep a record of the actual length of time the engines are working, and this amount, 5,000,000 gallons is figured from the records for two or three years; it varies some.

Adjourned to 2 P. M.

THURSDAY AFTERNOON SESSION.

The convention was called to order at 2.20, Vice President Kent in the chair.

The paper by Wilbur F. Leonard, C. E. of Watertown, Mass., upon "Ashland Basin No. 4," and the "Mixing and Handling of Concrete," which was read at this time, was listened to with attention and was followed by an animated discussion, and both the paper and the discussion, with full illustrations, will be published in the December number of the Journal. They are omitted now mainly on account of delay in obtaining the photo-lithographic plates.

AERATION AND FILTRATION OF WATER.

The following paper by Charles B. Brush, C. E., of Hoboken, N. J., was read by the Junior Editor.

There is a popular misapprehension in relation to a pure water supply for domestic purposes. Such water should not be in the condition of water that has been boiled and distilled. In that case it would be flat and unpalatable. If left standing any length of time exposed to the air and sun, it would soon develop an unpleasant taste and smell. Algæ would begin to form. Before long the water would actually become repulsive and it would remain in that condition until it went through what is sometimes called a "curing" process, that is to say, it would have to absorb sufficient air and pass through other conditions necessary to enable it to sustain life before it could be useful for domestic purposes.

It is absolutely essential to good water that there should exist in it a certain equilibrium of animal and vegetable life in order to produce and regulate the quality and quantity of gases essential to maintaining it in good condition. Prominent among these gases is oxygen. Not the oxygen of which the water is actually composed, but rather additional oxygen in solution in the water which varies greatly under different conditions. With an excess of oxygen in solution, stagnant water is never found. Filtered waters, or what are practically the same thing, waters obtained from subterranean sources of supply such as galleries or deep closed wells after passing through natural filter beds, are generally bright, clear, and quite palatable. If allowed to stand any length of time, however, especially in an open reservoir, such water soon deteriorates. Filtered water should be used as soon as possible after it has been obtained, and the quality of all water is injured to a greater or lesser extent by storage. The best supply is always obtained from water in motion. All waters, and especially those obtained from the surface streams, are better at some seasons of the year than at other seasons, and these seasons differ with the different sources of supply. Generally, however, the worst season with any surface

supply is either in midwinter or in midsummer. In the former case, when the streams are frozen over, the air is no longer in contact with the water and consequently the water lacks life. The plants along the stream are not growing and deleterious gases in the water are therefore not absorbed. In the heat of summer, especially after luxuriant vegetation, the oxygen in solution in the water seems to be used up to a more or less extent, and there is an excess of vegetable life. In both cases the result is a fishy taste and smell and algæ are likely to develop. The above remarks refer, of course, to waters that have not been contaminated by sewage or other refuse. Such contaminated waters are really less susceptible to the deterioration to which I have referred than waters in which no such contamination exists. They are often quite palatable and the poison can only be detected by chemical analyses or by its effects on consumers. Analyses should be made at least once in each month of the waters of every well regulated supply for cities and towns.

Filtration is essential, if perfectly clear water is required at all times from a surface supply. No matter what may be the stream, the water therefrom will become more or less turbid after heavy falls of rain. This discoloration can only be removed by filtration. It is not necessarily injurious to health, though it is certainly inconvenient and unpleasant. The larger the provision for storage and settlement, the less will *this* difficulty be encountered, but it never can be entirely obviated except by filtration.

The ideal source of supply for domestic purposes is the mountain stream. Here the water tumbles and dashes among the stones and becomes thoroughly air scrubbed. Pools on the mountain side through which the stream passes act as settling basins and the sand and gravel beds over and through which it flows are excellent filter beds.

Since we cannot, in most cases, obtain our supply from such a source, it becomes necessary to approximate it in the most practicable way. Filtration alone will not suffice, because while that removes the discoloration it also removes life from the water. Aeration alone will not answer, because that does not remove sediment and discoloration. A combination of both is often essential and always desirable.

Up to the present time very little attention has been paid to either of these methods of purification in this country. In Europe the whole attention of those interested seems to have been concentrated on filtration. The necessity of aeration even in Europe, however, is now being recognized and its necessity advocated.

FILTRATION IN EUROPE.

The difficulty with the European system is its enormous first cost and the great annual expense of maintenance. This system consists in the erection of filtering beds which are practically small reservoirs with collecting open brick drains in the bottom covered with filtering material about six and one-half feet thick. The first two feet in thickness around and over the drains consist of broken stone about two inches in diameter. Above this is placed a layer of gravel, pea size, about two feet thick; and still

further above is a layer of coarse, sharp sand about two and one-half feet thick. Each filtering basin is divided by a vertical wall into two parts for convenience of cleansing. In the worst stage of the English rivers the filter beds are cleaned about once a week. This is done by removing a thin paring of sand from one-half to three quarters of an inch in thickness, and these parings are continued until from eight to twelve inches of the sand is removed before the sand is renewed. It has been found cheaper to furnish new sand than to attempt to clean the old sand thus removed. The lowering of the water from twelve to eighteen inches below the surface is sufficient to admit of workmen removing the crust of sediment that has collected. The best results in cleansing are obtained when half a cubic foot of water per hour is allowed to filter through one square foot of sand surface. The minimum velocity should be about three-tenths of a cubic foot and the maximum about seven-tenths. If the velocity is too small the sediment will pack, if too great the water will wash away the sand. The annual cost of filtration in England has been from two dollars and a half to five dollars per million gallons filtered, exclusive of first cost and interest. In natural filter beds, such as underground galleries, the rate of filtration has been found to be from eight-tenths to one and six-tenths cubic feet per square foot of surface per hour.

FILTRATION IN THE UNITED STATES.

Until very recently very few filtering works have been erected in this country. The prevailing idea has been that there must be some better and more economical method than any as yet employed in Europe, especially to avoid the considerable manual labor required in cleansing a filter bed. Many crude devices and complicated systems of pipes, wasteful in their use of water, have been suggested; but until recently nothing practical has been made public. As is well known, the efficient part of a filter bed is the top layer of sand, which need not be more than two feet in thickness. The broken stone and gravel that are used are only valuable to protect the drains and support the sand. By the American system recently prepared, perforated double pipes with an annular space filled in with coarse gravel, are placed in a bed of sand in a circular iron tank. The filtered water runs through these double pipes while the sand is arrested. There are two systems of pipes, one about six inches below the surface of the sand and the other near the bottom of the bed of sand. When it is necessary to cleanse the filter, a reverse current of filtered water is sent upwards under pressure through these pipes and the impurities are washed out and floated away. This cleansing process is done at least once and sometimes twice a day. The advantage of this system are economy in first cost and also in maintenance and time required for cleansing. Details of this cost, however, are not at hand in consequence of the recent introduction of this system and also in consequence of the fact that serious litigation is pending by rival interests, working on what is apparently much the same principle with differences in detail. Notices of infringement of patents are now in circulation, together with replies thereto from the respective parties. These parties are The Newark Filtering Company

and The National Water Purifying Company, both of which concerns have their principal offices in New York city. I have no doubt that when the legal differences between these two companies are settled, that their general system of filtration will become deservedly popular throughout this country at least, if not in Europe.

AERATION.

As above stated, filtration alone is not sufficient. In order to have a perfect system of purification it will be necessary to combine filtration with aeration. Aeration can be accomplished in several ways:

First: By spraying the water. In order that this method should be effectual it is necessary to throw the water to a great height. When the head of the supply is sufficiently great as it is in some cities, as for instance, Rochester, this method is comparatively effective and economical. When the head, however, has to be obtained artificially as by pumping, the cost renders it impracticable.

Second: By mechanically forcing air through the water.

The benefit of aeration of polluted water has been recognized from time immemorial, and has been made the subject of certain patents in this country by R. D'Heuruse, but these involve the introduction of air at merely atmospheric pressure. Dr. A. R. Leeds controls these patents, but has improved upon them by introducing air under great pressure, which not only causes the work of purification to be very rapidly and effectually performed, but makes the process of such a character as to be easily applied in practice. It has been in successful operation on the works of the Hackensack Water Company since September, 1884, and has been introduced on the water supply of Greenwood Cemetery in Brooklyn, and also on the supply of Philadelphia. On the former works free air is forced into the water under pressures ranging from 110 to 125 pounds per square inch. As the air comes in contact with the water, the oxygen in the air is liberated and passes into solution in the water. Actual experiments have shown that free air forced into water under a pressure of 118 pounds per square inch (the quantity of free air being one-quarter of one per cent. of the quantity of water) has raised the amount of oxygen in solution in the water from 5.5 to 9.2 cubic centimetres per liter, after having been forced through a 20 inch main 14 miles in length.

The normal quantity of oxygen in solution in good water is about 6.5 cubic centimetres per liter ($\frac{65}{100}$ of one per cent. by volume). When it falls below this amount the water needs attention. It is not uncommon in surface water supplies at certain seasons of the year to find that it has fallen to as low as 3 cubic centimetres, and the water obtained from driven wells and galleries when fresh pumped rarely contains more than this amount.

The idea of clearing up stagnant water by infusion of fresh air has been practiced for many years on old cisterns, the water of which has been aerated by an aparatus very much like the ordinary chain pump, which by a system of small buckets carries the air down into the water and rising on the other side carries part of the water back into the air. With

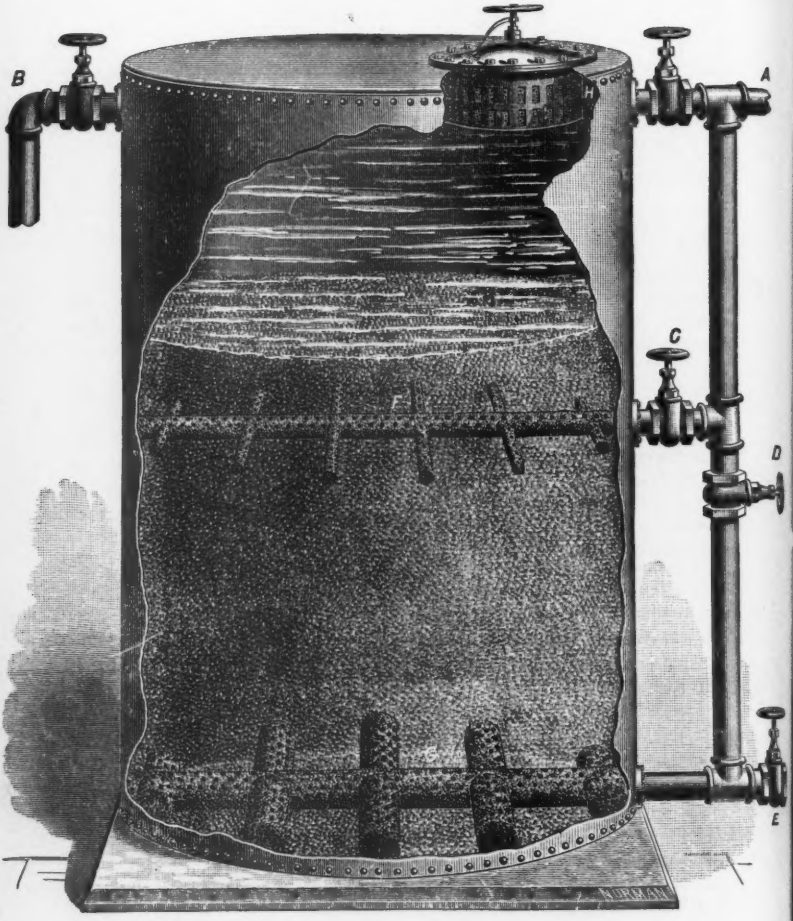
such an arrangement a cistern which is stagnant and offensive will in a short time become perfectly clear.

The effect of forcing air through water in mains has not been found, as would naturally be supposed, injurious to the operation of the plant. In any event air cocks will have to be provided on the summits of the main and experience will soon show how often these air cocks must be blown off. This will have to be done in any event from time to time, whether air is forced into the mains or not. My own experience has been that if the air is blown off once a week, that will be sufficient.

The amount of air that should be forced into the main has different limits at different seasons and under different conditions. I have found that when an excess of air is forced into the mains it is forced back on the pumps and they commence to jump. This limit also seems to indicate the amount of air required to keep the water in good condition. Determining the limit in this way, I find that it ranges from one-quarter of one per cent. in the spring and fall to six per cent. in midsummer under the conditions above stated on the works of the Hackensack Water Company.

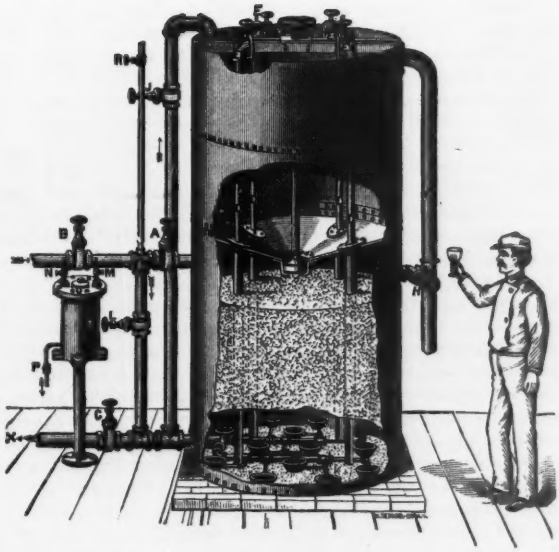
Both of the American Filtration Companies to which I have referred in this paper recognize the necessity of aeration in connection with filtration. Mr. Hyatt is the inventor of the system adopted by the Newark Filtering Company, and Mr. Deutsch and Dr. Leeds are the inventors of the system adopted by the National Water Purifying Company. Each company claims that the other company is infringing on its patents.

In preparing this paper I have, in addition to my own information and experience, obtained additional data from the report of the late James P. Kirkwood, Civil Engineer, on the Filtration of River Waters, published by D. Van Nostrand, New York, 1869; from a treatise on Water Supply by the late Wm. Ripley Nichols, published by John Wiley & Sons, 1883; and from a lecture delivered by Dr. Leeds, Dec. 23d, 1886, and published in the Journal of the Franklin Institute of Philadelphia, (February, 1887), on the Purification of Water Supplies of Cities.



The Filter of

THE NATIONAL WATER PURIFYING CO.



The above cut represents the apparatus of the

HYATT PURE WATER CO.

(Formerly the Newark Filtering Co.)

DISCUSSION.

The Chairman. The discussion of Mr. Brush's paper is now in order, and we would like to hear from Mr. FitzGerald.

Mr. FitzGerald. I do not feel like opening this discussion. In the first place, I know but very little about the subject, except what I have read, and I think these discussions are very much more valuable when we can speak from actual experience. I noticed one or two things in the paper that I thought I should like to speak about at the proper time, but they are minor points. There are two divisions to this subject, one filtration and the other aeration. I have always been at a loss to understand how the advocates of these particular machines could take the stand they have in condemnation of the old methods of filtration. It always seemed to me that the most perfect methods of filtration are those in which it takes water the longest time to go through the largest amount of material. Of course, those of you who have works where the water is taken from natural filters, from underground filter galleries, know very well how good the water is that comes from them, and that water has had the longest time to filter and the largest amount of material to go through. I am at a loss to understand how water in passing through a small amount of material in a very short time can be more perfectly filtered than that which is filtered by the old methods which have been in vogue for so many years in England and on the Continent.

There is one other thing spoken of in the paper, in connection with filtration, and that is the removal of the color from water. It seems to me that must refer to water which is discolored by some impurities which are held in suspension. In all the experiments I have been familiar with, where water, for instance, like some of the water of the Charles or the Sudbury, has been discolored by vegetable impurities which are in chemical solution, I do not believe the discoloration has been removed. I have never been able to see its removal a short time after the first use of the filter, if it has been removed at all. I should like to hear on that point from some gentlemen here who have had experience in regard to it.

In regard to the midsummer and midwinter difficulty, it seems to me that it is very much with that as with the other matters we were talking about,—that is, there is no hard and fast rule about it. It depends a good deal on how far your town or city is from the source of the supply, how large the draught is, and what it goes through. When the water in Boston has been bad it has been owing, I think, to causes which have been working for some time before; and it has taken a long time for it to be noticed in the city because our aqueducts are long and our reservoirs are large. The trouble has generally been in the early winter, and has been, perhaps, the result of the decomposition of vegetable matter that has taken place in the autumn. I think this matter of filtration and aeration is a remarkably interesting one, and I hope it will be fully discussed here to-day.

Mr. Billings. You will remember that the name of Dr. A. R. Leeds was mentioned in the paper as a gentleman who is interested in this subject. Yesterday morning I received a telegram from Mr. Brush, the au-

thor of the paper, saying that Dr. Leeds was to be here to-day and bespeaking for him the courtesy of the Association. I, therefore, on behalf of Mr. Brush, ask permission to introduce Dr. Leeds, and to say to him that if he has anything to say to us on the general principles of aeration and filtration we shall be happy to hear from him. I take pleasure in presenting Dr. A. R. Leeds of Hoboken.

Dr. Leeds. It gives me great pleasure to address on this topic a convention of gentlemen who are brought face to face with the practical problems of the water works management. I have been compelled to approach the subject from a somewhat different standpoint. It has been my duty during the past fifteen years to serve as consulting chemist of the water boards of a number of our cities and for special health commissions, as, for example, the special commission of Philadelphia and Wilmington, Newark, Jersey City and other towns. The practical difficulty which I have found, working as a chemist, has been that when I have sent in my reports of analyses they have usually been received in a formal sort of way and pigeon-holed. And the thing that is so desirable to do, viz., to effect some *practical improvement by means of this chemical work* in the matter of the water supply of these cities and towns, has been the difficult, in fact, the almost insuperable problem.

It seems to me astonishing that at the present time, so far as I know, only two large cities in the country have water of unexceptionable quality. These I believe to be Brooklyn and Rochester. None of the others, taking them in their descending order, Washington, Baltimore, Philaphia, New York and so on down; none of the larger cities in this country, with the exception of the two I have mentioned, so far as I know, have water of unexceptionable quality. And by that I mean to say water which in the eyes of our brethren of England and Scotland would be regarded as water that is equal in quality to the present reasonable requirements of a water drinking public. I was so deeply impressed with this matter that, after serving the Newark and Jersey City Boards for five years,—and they are drinking water there so contaminated that the Thames river, at the time when the special commission composed of Liebig and Hofmann reported on its unutterably filthy condition, was scarcely worse,—the acqueduct boards of these two cities asked me to spend last summer in England and Scotland in looking over their methods of water purification. It was an exceedingly interesting visit. Nothing could exceed the courtesy and the intelligence, as I found it, of the engineers in charge of the great water plants of England. And I was amazed to find that in point of water works management I saw there a development of the art so far beyond anything which I have seen here, that I can only think that in these respects, at least, we in America are very much behind the age. I found gigantic sums of money invested by hard-fisted and practical people like the English, which would stagger any water works committee in this country before which an engineer might dare to bring such colums of figures. When I came to examine practically the question, what shall be done with these polluted water supplies, I was brought face to face with the fact that in America our practice is so utterly different from what it is in England, and there were such difficulties to be overcome, that the first steps seemed

to be extremely difficult. To begin with, so far as I know, we have no filter bed in successful operation in the United States. Mr. Billings suggests Poughkeepsie; that is not in operation, gentlemen, at the time when it is wanted. When the temperature of the water gets above 70 degrees and the algæ develop, they send the water into the town unfiltered, in its very worst condition. The Poughkeepsie filter beds, so far as relieving the citizens of Poughkeepsie from drinking impure water is concerned, are a failure.

Now, the starting point of this inquiry, curiously enough, was not from the midsummer difficulty, and we know how serious that is, but from the midwinter difficulty. In February and in January of 1883 the water supply of Philadelphia, taken from the Schuylkill at Fairmount and Spring Garden, became incredibly offensive to taste and smell. It could not be used in cooking without the smell from the heated water diffusing through the house becoming so intolerable that people would open their windows for relief. Dr. McFadden, at the time engineer in charge, asked me to examine into the causes producing this state of the water; and when I had been on to Philadelphia and obtained the samples and made a complete analysis, or rather many analyses, of the various sanitary factors bearing upon the organic constituents and the mineral constituents, there was not one iota of information developed as to the nature of the difficulty with regard to the water. The water contained a good deal of sewage, but so it does at all times,—the town of Manayunk, a manufacturing place of 7000 people, pours all its sewage into the water supply of the city of Philadelphia only eight miles above where it is taken at the pumping station;—and the fact that the water contained this sewage, in midwinter, when the temperature was only a quarter of a degree above the freezing point, would not explain why it was so offensive.

It then appeared to me that as the taste and smell were owing to conditions which appeal to the senses, there was probably something in the nature of a volatile constituent, which would escape an examination for the organic material and for the mineral, and this would be the true culprit; and I made a number of complete examinations of the *gaseous* constituents dissolved in the water. Then I found, at a time when the water ought to have had its maximum of oxygen in solution, being as it was at a point just above the freezing, the amount of oxygen in the Schuylkill water had fallen to a little over three cubic centimeters per liter, while in its normal condition it contains six and a half. At that time the Schuylkill river was ice-bound from its upper waters down to the Fairmount dam. It flowed 90 miles under a solid crust of ice. Unfortunately the city of Philadelphia, when it laid out Fairmout Park, not so much to beautify the city as to protect the water supply, prohibited the cutting of the ice upon the water works forebay, because the city did not want the park defaced. Up to that time they had allowed the ice to be cut for a number of miles above the intakes, but when that privilege was rescinded the result was that the water had no chance to get air during all this flow. In that ice-bound condition it had received the sewage of Phoenixville and Manayunk and a population numbering over 200,000 in all on the upper Schuylkill. This sewage matter had been dissolved in the water

and it had had no opportunity whatsoever for undergoing oxidation. Why, gentlemen, the fact that putrefactive decomposition had taken place in the water was as noticeable as I think it is possible for any such fact to be. You all know that if you allow oxygen to come in contact with decomposable organic matter, flesh or vegetable, it oxidizes the carbon into carbonic acid, it oxidizes the hydrogen into water, it oxidizes the nitrogen into nitrous acid and nitric acid and that these products of oxidation are harmless. The more of such oxygen products we get the better. But shut out the contact of oxygen with that decomposing matter and what do you have? You have the products of putrefactive decomposition; you get hydro-carbon bodies in the nature of paraffines and olefines,—in common language, bodies in the nature of coal gas. And those bodies were present, dissolved in the Schuylkill water at that time. When holes were cut in the ice and the gases which were under pressure there were allowed to come out, they were inflammable gases, *they were hydro-carbons, and when a match was applied to such a hole it would give a flame a yard in height.*

It seemed if this train of reasoning were true,—and I submitted it to Mr. Cheesborough, Mr. Frederick Gräff, Mr. Vaughan Merrick and Col. Ludlow,—that the way of treating the Philadelphia water was to supply it with what the city authorities had robbed it of, i. e., give back its oxygen, of which they had deprived it when they allowed the water to become ice-covered. I proposed to Col. Ludlow at that time to attach an air-pumping engine at the bottom of the mains and drive air in under the pressure in the ascending mains. The samples were taken back to the laboratory and air was driven through them under pressure. When artificially the percentage of oxygen in solution was raised from three cubic centimeters to the normal amount, in these experiments made in the laboratory, 50 per cent. of the putrefiable organic matter in solution underwent oxidation.

The results were so encouraging that they led up to putting the apparatus in practical form, and an experiment was made by Col. Ludlow on the 40-inch Corinthian main by means of a temporary engine for pumping air. The result was favorable, and he asked the Council of Philadelphia to appropriate $10,000, which they did, and the fact that the pumps have not all been put in operation up to the present time is due to the bad construction of the mains. He had to repair one which crossed the Schuylkill, which was leaking a million and a half gallons a day.

While the subject was in this condition the Hackensack Water Company, a private company, got into a most embarassing position. In the summer of 1884 the water became very offensive indeed, and the city threatened the water company with a suit for breach of contract. Both the counsel of the city and the water company, it so happened, applied to me at the time to investigate the cause of the difficulty. Mr. Brush was the presiding engineer. The water is taken from the Hakensack river, which was recommended by Mr. Kirkwood as the best possible supply for Hoboken. It came from a drainage area in all respects so satisfactory, he said, that Hoboken would always have an ample supply of perfectly satisfactory water. The company adopted his recommendation, and suddenly they found themselves threatened with a breach of contract by the city.

I went with Mr. Brush over the drainage area of the Hackensack river at the time when the water in the town was so offensive,—it is a town of 40,000 people using this water and the supply is about 4,000,000 gallons per diem,—I went with Mr. Brush along the line of the Hackensack, and there was not a factory, there was not a drain nor a cess-pool nor any contamination of that kind on the stream, so far as we could discover, but at the same time there was this terrible condition of the water. After spending the entire day investigating the stream I said to my friend, Mr. Brush, "It seems to me it is impossible to explain what we see here, except that you have impounded somewhere the water of the Hackensack river." But he said, "No, it is not impounded." "Well, then," I said, "the explanation of this difficulty is entirely beyond me." But I didn't want to give up the examination too hastily, and said to Mr. Brush, "What is the condition of your reservoir?" And he replied, "It is perfectly satisfactory, I was there this morning." Nevertheless we went to the reservoir and found there an astonishing spectacle. The whole surface of that reservoir, holding 15,000,000 gallons, which Mr. Brush had left in the morning in a satisfactory condition, the whole surface of that reservoir was covered with a green crust, streaked with patches of deeply colored indigo and blue, with here and there masses of white foam. It looked as though a dyeing establishment had turned its entire refuse upon the top of the reservoir; and I verily believe animals would have gone upon that surface and thought they were treading upon firm ground.

I happen to live in a town principally inhabited by Germans, and the mayor of the city took a beer bottle and went up to the reservoir and scooped up some of this scum and came down to the mass meeting of the citizens in the evening and said, showing it to them, "Citizens of Hoboken, this is the water you drink." A friend of mine, referring to the mayor's German proclivities, says he put it to the people of Hoboken in this way, "This is the water *you* drink." Anyhow, the effect was so great that unquestionably the suit would have been brought, and Mr. Brush was most anxious to stave off the litigation. When he asked what should be done, I said, "Mr. Brush you know the history of these experiments in Philadelphia, and there are only two things I can think of: You must either resort at once to some effective method of filtration, or you must destroy that condition of stagnation. You have nominally a reservoir, but it is really a stagnant pool. You must destroy the stagnation and make it into living water, and I don't know of any way you can do that unless you drive in enough air to raise the oxygen to the normal percentage." He could not do so immediately, but he went over at once to the factory, ordered his apparatus, got in readiness as quickly as he could, and the very next time this trouble was threatened he put the air compresser on, the trouble disappeared, and has not reappeared since. All the water of Hoboken has been aerated now for the past three years.

You have heard of the experience at Greenwood Cemetery. There they have a number of lakes supplied with water from driven wells, perfectly pure filtered water out of the sands of Long Island. The water became very offensive in the summer time, and Mr. Brush, the Consulting Engineer of the Cemetery, consulted me with regard to it. I made an ex-

amination and found a very large amount of carbonic acid in solution in the water, a large amount of nitrates and a great deficiency of oxygen, together with an enormous growth of diatomaceæ, especially of the species *Navicula Viridis*, and of the protoplasmic slime which the diatomaceæ secrete. Such being the case I recommended,—"Either cover the reservoir or aerate it." He said, "We cannot cover it, for that would defeat the very purpose of ornament for which we put it here." So an air compresser was procured and attached to the descending main, and as the engineer said to people who went there last summer to see how the thing was working, whenever he saw any green on the reservoir he ran the compresser for all it was worth. I may say that last summer they had no difficulty, but we will have to see what the future will bring forth.

Now, so much for aeration. With regard to filtration, I think Mr. Brush's statement is judicial and fair. In the English filter bed what does the effective work is the two feet of sand on top. All the enormous and costly sub-structure is simply to provide a lot of filtering channels to take the filtered water away. The effective part of this great English construction *is the two feet of sand.* And I say "sand" because Mr. Binney, Engineer of the Manchester Water Works, showed me their experimental plant, and he told me they had thrown away everything else and were putting nothing in their filter beds but sand which they had come to the conclusion was the very best thing they could put in. Sir Francis Bolton, the Metropolitan Examiner of the London Water Supply, said to me in reference to the operation of the filter beds, "We know they are mostly mechanical in their operation, but to a small extent they are chemical." And how? What is a filter? We think of it as a lot of sand; but when we come to consider what that sand does, if it effects anything, it seems to me it is this:—It represents a vast number of small tubes of very small diameter and of a very tortuous path, and the operation of the filter is as follows: If a particle getting on the top of the bed can go all through one of these small tubes and not in some way be mechanically caught on the side, it will go through the filter, otherwise it is caught. But during all this time opportunity is given for the oxygen dissolved in the water to have its chemical effect. The long tortuous tubes provide time and opportunity for the oxygen to operate upon the organic matters. The operation is therefore two-fold,—the mechanical operation of stoppage and the chemical one of allowing time and opportunity for oxidation.

In the English filter bed, there is necessarily a very slow rate of filtration, and very little flow of water can get through it. It filters under very small pressure, very small head. But if you were to drive the water mechanically through a filter bed it would just as perfectly stop the suspended matter; and, so far as the chemical action is concerned, the chemical action is done when the oxygen has done its work; that is when the oxygen in solution in the water has been used up.

Now, when we come to face the matter practically in this country, I think it is quite certain, gentlemen, that we never will put in the English filter bed here. I asked Col. Ludlow to do it,—and if there was ever a progressive man he is that one, and he said, "No, the cost is too great; we can-

not think of it." With reference to the present water supply of Washington, he told me only a short time ago, "It is useless for you to advocate the English filter bed, the cost is too great; you must have some mechanical means for doing the work." I believe at the present day we are the last, we are at the very bottom with regard to what we are doing in the way of water purification. But I also believe that with such mechanical aids as we have in this country it will only be a few years before water engineers of this country will be at the head. A great field for activity is here presented for them, and they will soon build up an American system of water purification which in all its lines will be entirely different from the English system.

In a rational scheme of water purification the first step is effectually to *aerate* the water. This must be done in order to bring up the amount of oxygen to the highest possible point, to scrub out the volatile constituents, to remove the carbonic acid, to bring water into proper condition under pressure, under great pressure, under a pressure of 100 or 200 pounds to the square inch, if necessary; to drive the air under pressure into the water under pressure. When this has been done, the second step is to drive both together through a filter bed, not two feet thick, merely,—there is no need of stopping there,—but four feet. You can go into the Worthington Hydraulic Works to-day and see the refuse water at the works, filled with oil, filled with soap, filled with mud, filled with the urine of men at work there, put through an experimental plant on a small scale, to show the operation I speak of, and it comes out perfectly colorless and without any suspended matter whatsoever.

I will only detain you a moment longer to give you a practical illustration of the operation of this method. It is with regard to the town of Champaign, Ill., which has adopted this system of water purification. The water was yellow from peat, more yellow a great deal than the river water at the Taunton works, and it was loaded with organic matter. It was so hard, there was such an amount of lime in solution, as to be unfit for boiler use, it was difficult to use in the laundry, and it was turbid. By the decomposition of this peaty matter, by the oxidation, I should say, of the peaty matter, the carbonic matter, the carbonic acid in solution had increased to more than eight cubic centimeters whereas it should be almost nil. The oxygen had fallen to barely one cubic centimeter per liter. You add some lime water to the water of Champaign and you get an abundant, copious precipitate of carbonate of lime. When that drops to the bottom,—and it goes down as a lime precipitate,—it carries with it mechanically the suspended silt, it carries with it the microphytes and the bacteria, and not only so but much of the organic matter is carried down at the same time. The State Chemist of Illinois was so much impressed with these facts:—that you take out the lime, destroying the hardness, you take out the carbonic acid, you take out the silt which makes the water unsightly and at the same time you raise the percentage of oxygen to the maximum, that he strenuously advocated the adoption of the system, They are going to treat the whole supply of the town in the way I have been speaking of, and when the water is put through this process it comes

out so limpid, soft and sparkling that, gentlemen, if they simply put a little wine juice into it they may be tempted to sell the water by the name of the town (Applause.)

Mr. Darling. I move a vote of thanks be extended to the gentleman who has just addressed us for the very able, interesting and courteous manner in which he has put this matter before us.

Mr. Billings. I take pleasure in seconding Mr. Darling's motion.

The motion was adopted.

Adjourned to 7.30 P. M.

THURSDAY EVENING SESSION.

The convention was called to order at 7.45, Vice President Kent in the chair.

SHALL THE JOURNAL BE CONTINUED AS A QUARTERLY?

The Chairman. The first business in order for the evening is the discussion of the question, "Shall the Journal be continued as a Quarterly during the coming year?"

Mr. Darling I move you, for the purpose of bringing the subject before the Convention, that the matter be left to the discretion of the board of editors.

Mr. Billings. Your editors put that topic upon the programme because of some doubt in their minds as to whether or not it would be deemed advisable to go on. The doubts were not serious, however, and we made no preparation to come here and make any elaborate statement in regard to the Journal, either for or against it. We put the question upon the programme as much to set the members to thinking as for any other purpose, and with the hope, also, of getting from the members some expression of their opinions about the matter. I can say that as far as I am concerned, as one of the editors, I feel encouraged to go on with the publication this year, and I am quite sure that my associates share in the feeling. I do not want to let this opportunity pass, however, without assuring every member of the Association that he can do something to make the Journal better and make the work of the editors easier, if he will have the Journal in mind and occasionally write to us with suggestions, and send us some matter, be it ever so simple, in the way of description of new work, a sketch of some new device, or anything of that sort which may be interesting. We do not wish to interfere at all with the blue print scheme, and this would not, for that has a place of its own. Judging from what we have heard the last few days, we have plenty of matter for the next number, and there are one or two things in prospect which will, perhaps, serve for following numbers. But I do hope we may be spared the anxiety which we have had at times during the past year, coming from the fear that we were not going to have suitable matter enough to fill out the four numbers. As it happened we came out all right. But please bear us in mind, and send us matter and copy whenever you can, or put us on the track of anything which you think would be of interest, and we will be grateful to you and promise to use it to the best of our ability.

Mr. Richards. I think there can be no doubt in the mind of any member of this Association that the Journal of the past year has been a very valuable publication, and that it ought to be continued That certainly is my opinion, and I hope the publication will be continued.

The Chairman. I most heartily endorse what Mr. Richards says.

Mr. Darling's motion was adopted.

WHAT CAN BE DONE TO INCREASE THE VALUE OF THE SCHEME FOR EXCHANGING SKETCHES?

The Chairman. The next business is the consideration of the subject, "What can be done to increase the value of the scheme for exchanging Sketches?" I will call, now, for the report of the Committee on Exchange of Sketches.

Mr. Sherman. The report of the Committee on Exchange of Sketches was recommitted to it for an adjustment of a matter which seemed to run against the grain of the members; I hope it ran against the grain of every one of them,—it was written for that purpose. (Laughter.) Now, with your permission, we will present it in a little different form, and hope it will be acceptable,

DISTRIBUTION OF SKETCHES.

Mr. Sherman presented the following as the amended portion of the report of the committee.

One of the topics for discussion this evening is "What can be done to increase the value of the scheme for Exchanging Sketches?" Your Committee earnestly hope that every member will speak on this question and that some new way may be devised to increase the interest in this subject, (all previous methods of persuasion having failed) and that the next Annual Meeting may bring as many sketches for exchange as there are members.

The same members have brought blues for exchange year after year, and the new converts this year are but few. It is the decided opinion of the Committee, that if this scheme fails of success next year, that it is useless to pursue it and should be abandoned.

Mr. Ball. To fulfil one of the recommendations of the report which has been so ably presented by Mr. Sherman, that every member would speak upon the question, I rise to say a few words. I sympathized very earnestly and cordially with Mr. Sherman when he was speaking last night so disparagingly about the success of the blue print project. It is a valuable aid to the members of the society, and it should be maintained and perfected if possible. But, to take my own case, I have known ever since I was a member of the Association of this call for blue prints. The call has been that every member should send in something,—it has not been stated what.

Now, we are all boys to a greater or less extent. Sometimes a father has a bright, active boy and he wants to teach him to shoot. He gets him a gun gives him some powder and shot and all the paraphernalia, and on some

pleasant morning tells him to go out and learn to shoot. The boy goes out; the sun is shining brightly, he sees everything about him, the trees and fences and posts and all that sort of thing, but he doesn't see anything to shoot at. If the father, when he told the boy to go out and shoot, had told him to take a piece of paper a foot square and draw four circles on it and put a black mark an inch in diameter in the centre and then pin the paper on a tree, move back thirty paces, aim his gun at it and see how near he could come to hitting the spot in the centre, he would have accomplished something.

Now, I feel precisely like that in regard to this blue print business; and, having expressed my feeling about it, I am going to make this motion: That at the next annual meeting each member of the Association, in order to put it in definite shape, be requested to furnish a blue print of a sketch of a gate house, including the gate and the peculiar method upon his work of taking water from the reservoir; and that at the next annual meeting these blue prints shall be presented and shall receive one full afternoon's discussion, as to the relative merits and demerits of the various methods of taking water from reservoirs and from the various inlets into the supply pipes, pumps and other things which there are on the various works. I make that as a motion. I shall not be discouraged if you say it should go on the table, or if you refuse to adopt it, only I hope, if you do, you will put something better in its place.

Mr. Sherman. I would second the motion. I like the idea very much. Now that the matter is before the house, however, I don't want it to be passed without more talk upon it. I should like to hear every member speak to the question before a vote is taken. There is only one objection to the motion, and that is there may be some cases where there is no gate house; as for instance, a man pumps direct or pumps right from a well, and he may not have a gate house.

Mr. Ball. I intend for them to furnish a blue print of a sketch of the method by which they take their water, including the initial apparatus. They may include their well, if they choose; they may include the filter gallery if they choose. That would be my idea, to represent the various modes of taking water, all the varieties of ways in which it is done; because it will be found that there are about as many different ways of taking water as there are of making water assessments. Hardly any two ways are alike, and yet each has its peculiar merits, and some their radical defects.

Mr. Billings. I was thinking I should have to ask for further instructions, because there isn't a gate house on the Taunton works to my knowledge; but we have to take water through gates into the pump well, and I presume those pump well gates and the connection with the filter gallery or basin would be within the line?

Mr. Ball. Certainly. My idea about the matter is that if the Association could concentrate its main thought upon some particular thing in connection with the blue prints,—it may not be the subject I have suggested; there is not the slightest objection to taking the general construction of dams or any other department of the works,—in a few years you

will have a mass of information that is valuable beyond expression. You will get at the history of water works construction as you can in no other way. At the same time, if a gentleman desires to bring in a blue print of something else besides his gate house, there will be no objection to his doing it; but let all bring in a blue print of something bearing upon the subject assigned.

Mr. Darling. I am reminded of the story of the fellow who tumbled down and broke his leg, and a crowd of people gathered about him and they all said, "Poor fellow, his leg is broken! Isn't that too bad!" By and by there came along a man who said, "It is too bad for $5," and he took out his pocket-book and gave the poor fellow $5. Now, I will promise to bring a blue print next year, showing the manner in which we take our water into the pumping station, if the Lord is willing I should live to do it. Now, I want to know what other Superintendent will get up here and say he will do the same thing. I think we can get at it in that way. Come, gentlemen, don't be bashful, but get up as fast as you can. (Laughter.)

(Several members rose.)

Mr. McClintock. I am a new member of the Association, and one of the things that induced me to join was this exchange of sketches. We have no gate house, but we are putting in a high service, and I will promise to bring a sketch next year.

Mr. Richards. I move to amend Mr. Ball's motion so that it will read this way: *Resolved*, That every member of this Association bring a blue print at the next meeting of his gate house or of some other structure as indicated by Mr. Ball's motion.

Mr Ball. I accept the amendment.

Mr. Noyes. I do not know but I ought to be ashamed to speak on this subject, because individually I have not co-operated as I ought to have done in the matter of furnishing blue prints; but I wish to agree now that a tracing of the Newton works shall be furnished next year. I think, perhaps, the thought has come to other members, as it has to me, during the past year, "What is there of interest connected with my works that would be of interest to others?" I have often said to myself, when I have been looking into something in connection with my official duties, that I would make a blue print; but when I came to select I would think, well, that won't be of any interest, or, that is covered in the report, or something of that kind, and I would drop the subject, thinking some other would present itself; and so the whole thing would finally go by. It may be that some of the rest of you have found yourself in the same predicament. I was impressed with the exceeding value of the blues when I saw the collection of reservoirs and embankments which had been compiled by Mr. Richards, I think; and the value of those details is so great that I felt ashamed of myself to think I had not forwarded the same thing myself. I will now agree that a print of our works shall be furnished.

Mr. Winslow. If I should make a sketch of my works, in what way could I get it put into the shape of those here, that is as to size? Is there any transferring, or is it photographed, or what is the process of reducing it to the size of these, or must it be drawn to that size?

Mr. Billings. It is not necessary the sketches should be to a scale. If you will take a sheet 10x15, and refer to the third number of the Journal you will find a diagram showing exactly the size the sketch should be, and full directions. All you have got to do is to bring the lines of your sketch within the margin of that sheet, without paying any attention to the scale, if you are making a diagram of your whole works.

Mr. Richards. I think it would be a good plan, after discharging this Committee on Exchange of Sketches, to appoint a fresh committe with directions to prepare and send out to the members full directions as to making the blue prints.

Mr. Learned. There seems to be a pretty general feeling with regard to the advantage of these blue prints, and a wish that their exchange may be continued. The fact is we all like to receive them, but we do not all like to make them. The question of the number we would have to make for each meeting is, perhaps, an embarrassing one to some. But in order to pin this matter right down and get the sense of the meeting, I move that the members express by raising their hands whether they will or will not furnish blue prints next year. I think if all the members here would agree to bring them, that would be enough to keep the thing going.

Mr. Darling. While I fully endorse the gentleman's remarks, yet some gentleman may feel a little dffident about committing themselves one way or the other at the present time. I would respectfully suggest that it be understood that anyone who is not prepared now to say he will join in the blue scheme will be gladly received into the fold whenever he is ready to come. (Laughter.)

Mr. Hawes. I think it would be a little arbitrary to pass Mr. Learned's motion. There are some members who have never looked into this business of blue printing; they don't understand how it is done, and it will be a good deal of trouble for them to rig up to do it. It might look a little stubborn for a man to refuse to say he will do it, when, really, he will do it if he can but doesn't feel like saying absolutly he will. Perhaps our Superintendent will learn how to do it before next year.

Mr. Learned. I didn't intend to have the motion considered as arbitrary or anything of the kind; but I feel, as probably a great many others do, that I would like to continue to receive the blue prints. I must confess, however, that I have not furnished any yet, but rather than not receive any more I shall be very happy to go ahead and make a blue print, and help do my part towards keeping up this system.

Mr. Stacey. I would like to inquire if there are not some parties in the business who have occasion to do a good deal of this work, and if some arrangement could not be made with them to furnish the blue prints after the sketch is prepared? One of the greatest pull-backs has been the lack of any particular subject to work on. Now that difficulty has been removed, and if all the members have got to do is to make a sketch and send it to Boston or to some other place where they can get the blue prints fur-

nished at a nominal cost, it will perhaps relieve some of the Superintendents from embarrassment, especially if they do not have the time to attend to it or rig up for it themselves. It doesn't seem to me there could be any excuse for any man not furnishing something under such circumstances. He has got a subject, and he can sit up nights, if necessary, and make a sketch; then for a trifling expense he can get his blues made, and will receive many times the value in return. It seems to me that might be done. I am not familiar with the business, but I think there are parties who do blue printing who will be willing to undertake the work for a nominal compensation.

Mr. Sherman. I think if the Secretary will read, or let me read, a portion of the report, the gentleman who last spoke will see that this suggestion in regard to the offer of the Institute of Technology is not confined merely to these drawings which have been presented to-day, but to any others. "The committee have information that the Massachusetts Institute of Technology, Boston, will, if desired, furnish prints from these drawings, or any others of equal size, for the sum of five cents each, not including postage." Any member who does not have an apparatus of his own can get 100 copies of his sketch for $5, to exchange for 100 copies of other sketches. All the speakers refer to blue prints, but it is not necessary that we should have blue prints, copies may be made by any other process. We had one or more hektograph copies furnished to-day, and they are equally as good as the blue prints. They can be furnished in any form that it is easiest for the members to furnish them.

Mr. Ball. I would say just a word about the matter of procuring blue prints. I have no doubt but upon inquiry in the city of Manchester you will find at least half a dozen individuals who are practicing the blue print process. My impression is there are more than a dozen in Worcester. I have no doubt there are some of them who would be glad to furnish any number of prints for a reasonable compensation at any time; and I haven't any doubt but what in the town where my friend comes from, if he will look around there he will find two or three people who are familiar with the blue print process and are practicing it. Then, of course, as has been suggested by Mr. Sherman, there are various other processes which are kindred to it, which will give work equally as good as the blue print process, and which, of course, will be as acceptable as an ordinary blue print.

The Chairman. The motion before the meeting is that each member of the Association furnish for the next annual meeting a sketch of his gate house or some similar structure.

Adopted.

Mr. Fuller. I would like to say that there is a firm in Boston which makes a business of taking these blue prints, and I have no doubt if they could take a number of sketches and do them whenever they had an opportunity, they could do the work very reasonably. I don't know whether it would be any cheaper than the price which has been mentioned, but, at any rate there would be no difficulty in getting the work done at that price. All a member would have to do would be to prepare his sketch

and send it to this party, and when the time came around he would have his blue prints all right.

The Chairman. Any member who is unable to furnish his own blue prints will be put on the right track if he will address any member of the committee.

Mr. Noyes. In connection with Mr. Ball's suggestion that we have a full discussion at the next meeting in regard to gate houses, etc., it is also suggested that in order to get the greatest value from the discussion it might be well to have these prints sent to the Secretary or the Board of Editors, whichever might be deemed best, and have the exchanges made before the meeting. The members would then have an opportunity to study the details of construction, and I think a greater value would be derived from the discussion. I don't know but it might entail a little more work than we think best to put upon the Secretary, but I certainly think it is a good idea to have some such exchange before we come to the meeting.

REPORT OF COMMITTEE TO OBTAIN INFORMATION UPON CAST IRON PIPE.

Mr. Sherman. There is a report of a committee due at this session which may furnish matter enough for discussion to last us up to the time of adjournment and with your permission Mr. Chairman, I would like to say a few words at this time, as Chairman of the committee to report as to the proper thickness of cast iron pipe. I do not know as that was the exact title of the committee, but we understood our work was to determine, if possible, the proper thickness of cast iron pipe under the various conditions of use to which it is put. The members of the Association will recollect that the committee made a partial report at the last meeting, and presented at that time a synopsis of the headings under which we proposed to treat the subject. We must now confess that the deeper we get into this subject the more fearful it appears. We have found that our position is no sinecure. Every water works represented in this Association has notions and ideas of its own, and it is a pretty delicate matter for any committee to revise those opinions and formulate anything which it can ask the Association to endorse. For instance, to come right to the point of the question, and something which has given the committee more trouble than anything else: In the last number of the Journal there is a compilation of statistics relating to main pipe work in various places, gathered from the reports for the year 1886. There are fourteen different works under heading 15, which give the "Range of pressure at centre for day and night in lbs.," and we find they run as follows: One from 50 to 60,—that is very light. Here is one that runs from 25 to 115 lbs.,—that is nearly five fold. Here is one from 30 to 120 lbs.,—that is four fold. Here is one from 45 to 100; another from 60 to 125, more than double; 78 to 160, more than double; 35 to 70, double. There are six out of that list of 14 where the maximum pressure is over double the minimum.

Of course, it is an easy matter for the committee to determine the proper thickness that cast iron pipe ought to be under a static pressure of

so many pounds, there is no great difficulty in that; but to say what the proper thickness of cast iron pipe is under all circumstances, as they actually occur in the different water works represented in this Association, is an entirely different matter. We have discussed the matter pro and con to see if we could find some apparatus which would give that ram. The amount of ram, as we look at it, is the whole secret of what the pipe has got to stand. It has got to stand the extreme ram; but what that ram is in the actual conditions of every day work we do not know.

Now, it has seemed to the committee, after careful consideration,—and we are willing to do anything we can do conscientiously and in a right way,—that the best thing we can do is to withdraw for the time being; that the members of the Association be constituted a committee of the whole, and that each member, as far as is practicable, determine, with what means he has at hand, what the actually varying conditions are, covering a term of months. The investigation cannot be made satisfactorily in any one day or any one month, but it ought to cover a long interval to make it of any value. As I say, the committee have decided that this is the most proper course to be pursued. After the information has been brought in, then a committee can be appointed to take it into consideration and see if something cannot be made of it.

Mr. Darling. I move that the report be accepted and the recommendation adopted.

Adopted.

Mr. Sherman. I would like to have those members who now have an Edson gauge, or any other gauge that will represent the range of pressure, signify it, so we may know who are prepared to co-operate.

Mr. Billings. I will say that in Taunton we keep two gauges going most all the time,—one, an Edson gauge, in the office constantly. It takes from a four inch main reduced from an eight which is very close to a sixteen. The water comes through an inch and a quarter pipe into the office, and there is practically nothing else on the line, nothing except a small basin in the corner of the office. But I find that even under those circumstances the fluctuation is so great that it keeps the pencil churning up and down constantly, unless I throttle the gauge very closely. To avoid the annoyance caused by the noise of the churning, and to avoid the wearing off of the pencil, I keep the gauge closely throttled, so the sudden variations of pressure are not recorded. If the increase of pressure is maintained for any considerable length of time the gauge faithfully records it, but a sudden elevation of pressure, such as would naturally come from the ram, would hardly be noted on the gauge. And I do not know how it is practicable to get at it, for I certainly cannot endure the everlasting churning the gauge makes if I leave it wide open, besides taking the risk of breaking it. We have another gauge, the Jones Peerless Recording Gauge, which I have been using the past six weeks by carrying it about to different parts of the city in a box and fastening it on to hydrants. I have taken it all over the city into the different sections, and by attaching it to a hydrant with a box, and leaving only a small piece of lead pipe exposed, we have no difficulty in getting twenty-four hour records of the variations of pressure on the main at that particular

point. I consider these records quite trustworthy, because they are taken through the hydrant which gives a full sized connection down to the main. I have only got one case of water ram as yet. It was caused by the closing of an eight inch gate which a man was using as a blow-off. He closed it quite suddenly, and there was a ram of 150 pounds. The gauge stood that without any trouble. I intend to continue these observations as long as the weather is suitable. Of course, when it comes cold weather I cannot do it, for the hydrant has to be left open all night, and that, of course, is impossible in cold weather. I should be glad to receive any suggestion from anyone as to the best method of using these gauges, especially this travelling gauge, either as to the method of attaching it or the time it should be left on.

Mr. French. I should like to ask Mr. Billings if he leaves the cock wide open in taking the measurements?

Mr. Billings. Yes, sir; on the hydrant. Even if the fluctuations are severe, as they are in some cases, it is not in my office and I do not hear the noise. The pencil can be sharpened every time the chart is changed.

BEST METHOD OF TESTING WATER METERS.

The Chairman. The next topic is. "Best method of testing water meters."

Mr. Billings. If the convention will bear with me for speaking so frequently, I will mention a common sense method of testing water meters which has brought comfort to my soul in two or three cases, and which may help some other man. It is applicable in the case of a consumer who is inclined to be cranky and very skeptical about the correctness of the meter, and who is sure he has not used as much water the past month as the meter registers. I have tried it on one or two occasions with marked success. The only apparatus needed is a couple of good sized washtubs and a sealed gallon measure, a measure you are sure is correct and that the consumer will agree is correct; and the test can be made in the man's own cellar, so he can have no chance to say that the meter has been taken to the shop and doctored. It simply consists in closing all the fixtures, or in closing the stop and waste so as to cut off the house, and then running the meter round till the 10 foot index finger comes to an even figure, and then running off one or two cubic feet by the meter, the amount depending on the capacity of the tub. Having measured the amount of water by the meter, measure it from one tub to the other with the gallon measure. The consumer will see plainly that the error is of no consequence. Most consumers are not very exact men, and when you measure a small quantity and meaure it in that way, even if there is a little error it is lost sight of by them;and in two of the cases where I have practiced this test, I assure you the confusion of the consumer was highly satisfactory to your humble servant.

Mr. Darling. I know a better way than that; I can beat that. (Laughter.) Whenever a cranky one comes in and says he hasn't used the water, he knows he hasn't, I say to him, "You think the meter is wrong?" "Yes." "Well, we have got a rule here in regard to such cases. I shall require you to come here and go to the house with the meter man, the

meter shall be taken off, carried down to the shop, put on a testing machine, and you shall see the water measured. Now, any day when you are ready to come here and have that done, my man will be ready to go with you any hour or any minute." I never had one come yet. (Laughter) I think that will beat two washtubs and a gallon measure.

ELECTION OF MEMBERS.

The Secretary read the following list of names of applicants for membership:

ACTIVE MEMBERS.

L. Frederic Rice, C. E. Boston, Mass.
S. S. Coolidge, C. E., Engineer, Council Bluffs, Iowa.
Professor Albert R. Leeds, Stevens Institute, Hoboken, N. J.
Solon M. Allis, Superintendent, Malden, Mass.
Winthrop M. Pitman, proprietor, North Conway, N. H.
A. E. Stearns, Water Registrar, Manchester, N. H.

ASSOCIATE MEMBERS.

Providence Cylinder Co., Providence, R. I.

HONORARY MEMBER.

Henry C. Meyer, Editor of *The Sanitary Engineer and Construction Record.*

The Secretary, by direction of the Convention, cast the ballot of the Association for the gentlemen whose names he had read and they were declared elected members.

THE PROPER SIZE FOR HYDRANTS.

Mr. Winslow. A little thing has come up in my town within the last two or three months which has caused some talk between myself and the Board of Engineers of the Fire Department, and that is in regard to the sizes of hydrants on the different mains. I want to put in a five-inch hydrant on a four or six-inch main, and on any larger main than that I am willing to put a larger hydrant. I would like to get the sizes used by different Superintendents, and find out whether they would recommend a six-inch hydrant on a six-inch main, or whether they think a five inch hydrant would answer. It looks to me that putting a six-inch hydrant onto a four-inch main is a good deal like putting a two and a half inch butt onto a two-inch hose. And, furthermore, a five-inch hydrant on any size main will supply a steamer with all the water she can take, and what more than that can be wanted is what I want to find out. I desire to know whether the Superintendents here would recommend putting a six-inch hydrant on a six-inch or a smaller main. If anybody will give me any information, I will be much obliged.

Mr. Richards. I should think it would depend somewhat on the number of streams you were going to take out of the hydrant. If you are only going to take out two streams, with two or three hundred feet of hose for

each stream, I should think the friction on a five-inch hydrant would be insignificant as compared with the friction on the hose. It seems to me a five-inch hydrant is big enough. If you are going to take out more streams, of course, you want a larger hydrant.

Mr. Winslow. I will give a few figures which show the result of a trial on one of our hydrants on a four-inch main. The hydrant had a static head of 44 lbs. With one steamer stream through 100 feet of hose they got 150 lbs. pressure on the engine. With two streams with 100 feet of hose they got 27½ lbs. at the hydrant, and the pressure on the engine ran up high enough to be satisfactory. With one hydrant stream and one steamer stream they got 70 lbs. on the steamer and 24 lbs. on the hydrant stream. With two steamer streams and one hose stream they got 60 lbs. on the steamer and 20 lbs on the hydrant. I will say here that they have adopted a system on our steamer that is a little different from what they have in some other places. They put on what they call a quick hitch,—that is, the hose from the hydrant to the steamer is a leading hose. It is a piece about 15 feet long, and by using that they can run up and stop the steamer without being obliged to stop it at a particular point, and they can catch on without any trouble. They used this on the hydrant with the pressure stated, for the sake of seeing whether they could collapse it or not. They could not collapse it, but it was the equivalent of it, because the hydrant would give them water enough to get, with their two steamer streams, 60 lbs. pressure, but it wouldn't give it to them fast enough to give them any more. With three streams from the hydrant alone they got 30 lbs. without the use of the steamer. With two steamer streams alone, without the hydrant stream, they got 90 lbs. on the steamer. Ninety pounds on the steamer, with two hydrant streams, gives a very fair working stream. When you take on a six-inch main you are going to get more pressure but, in my opinion, a five-inch hydrant is sufficient on a four or six-inch pipe. I would like, however, to get the opinion of some others.

Mr. Billings. I would suggest that possibly some of the difficulty in this case Mr. Winslow has presented may have come from the small size of the main in the street, the four-inch main; and that if he will calculate the sectional area of a five-inch hydrant, and consider that the short length of the hydrant makes a friction of not a great deal of consequence, he will find that an ordinary five inch hydrant will carry as much water as any reasonable number of streams that are likely to be taken from it. Four or five streams can be taken from a five-inch hydrant, and if sufficient water is not obtained it is not the fault of the hydrant but of the main that leads to it The area of a five-inch hydrant being represented, perhaps, by 25, and an inch and a half stream having a sectional area of 2¼, you can see you can have a large number of those inch and a half streams before you equal the capacity of the hydrant.

Mr. Richards. I think you make a mistake in comparing the sectional areas and not taking into consideration the friction on the hose.

Mr. Billings. I don't think it would make any difference in the case I was supposing. The friction on the hose would work to the advantage of the hydrant.

Mr. Richards. Of course it will every time, and we can use a smaller hydrant.

Mr. Winslow. I would like to ask if there is any member present who uses six-inch hydrants on six-inch mains or four-inch mains.

Mr. Darling. I use nothing but six-inch hydrants on the whole works, on the four-inch mains and on the six-inch mains. When I set a hydrant on a four-inch main, I have it play both ways.

Mr. Fuller. I would like to ask the gentleman if by a five-inch hydrant he means a five-inch inlet and five-inch gate hydrant?

Mr. Winslow. A five-inch inlet at the bottom of the hydrant and a six-inch pipe from the main to the hydrant. There is a five-inch standpipe, perhaps it is a little larger, five and a half.

Mr. Walker. Do you mean you tap a four-inch main with a six-inch hydrant.

Mr. Winslow. Yes, sir; there are some hydrants in town, which were put in when the works were first started, that are six-inches on a four-inch main. And in all cases, where we run from any main, six inches or four, we tap with a six-inch pipe.

PLACE FOR HOLDING THE NEXT ANNUAL MEETING.

The Chairman. The next question to come before the Convention is where to hold the next annual meeting.

Mr. Darling. I do not understand that there is any Superintennent who is desirous to have us visit him next year,—not but a good many would be glad to have us come, but no one is prepared at present to invite us. Under the circumstances, I would suggest that we go to Providence on our own responsibility, expecting to entertain ourselves and pay our own bills. I suggest Providence because it is a very central location and easy of access for all of us. There is a hotel there large enough to accommodate us handsomely, and we can take our wives with us. Then, on the last day. if you desire, after having finished your business on Thursday night, you can go down the harbor to Rocky Point or some other place,—and pay for it yourself, it will cost you fifteen cents or a quarter of a dollar down and back, and your dinner will cost you half a dollar. I move that our next annual meeting be in the city of Providence.

Mr. Richards. I will second the motion most heartily.

Adopted.

The Chairman. Where shall the fall meeting be held?

Mr. Noyes. I move that the arrangements for the fall meeting be left with the Executive Committee.

Adopted.

VOTE OF THANKS TO THE CITY OF MANCHESTER.

Mr. Darling. I move that a vote of thanks be extended to His Honor the Mayor and the city of Manchester, for the very courteous manner in which they bave received us, and a special vote of thanks to our friend and associate, Mr. Charles K. Walker.

Mr. Hawes. If the gentleman will allow me, I have written out a vote of thanks which I will offer as a substitute for his motion. A year ago, at

New Bedford; when the question came up as to where we should hold the next annual meeting, Mr. Walker rose and said: "Come up to old New Hampshire." I seconded that because I had been up there before and had been entertained in the city of Manchester. I now move the following vote:—

Voted, That the heartfelt thanks of the N. E. W. W. Association be extended to the Mayor, city officers and citizens of Manchester, N. H., and to their large-hearted, whole-souled, level-headed Supt. of Water Works, Charles K. Walker, Esq., for the kind reception, hearty and sumptuous entertainment, which they have given us on this occasion of our annual meeting.

Mr. Darling. I thank the gentleman. I cheerfully withdraw anything I had to say, and fully endorse every word of his motion.

Adopted.

THANKS TO THE PRESIDENT.

Mr. Richards. I move the thanks of this Association be tendered to Henry W. Rogers, the President, for the efficient manner in which he has filled the presidential chair during the past year.

Adopted.

THANKS TO VICE PRESIDENT KENT.

Mr. Billings. I desire to make a motion which I am sure is in the mind of every gentleman here, and especially in the minds of those of us who know the peculiar circumstances under which the gentleman who has presided so acceptably at our sessions which are now closing was placed. When it was learned a few days before the meeting of the Convention that our President could not be with us, we had to look about for some one to take his place; and we counted ourselves extremely fortunate in having a Vice President who so kindly consented to act as our Chairman. I do not need to remind you how well and impartially he has performed his duties, especially when we consider that he was called upon suddenly; and I take great pleasure in moving that the thanks of this Association be tendered to Mr. Kent for his ready response to the call made upon him, and for the efficient manner in which he has presided over our deliberations. I will ask the Secretary to put the motion.

Adopted.

The Chairman. Gentlemen, I thank you.

PRESIDENT DARLING TAKES THE CHAIR.

The Chairman. Now, President Darling, it becomes your duty to take the presidential chair and to preside at the meetings of the Association for the ensuing year. (Applause.)

President Darling. (Having taken the chair.) *Gentlemen of the New England Water Works Association:* I wish to extend to you my hearty thanks for the honor you have conferred upon me by choosing me to preside over your deliberations for the year to come. You can rest assured that I shall try to do my duty to the best of my ability, and I shall expect

the hearty co-operation of each of you. I do not propose to make any speech at this time, but I express my hope and belief that our Association will continue to be as prosperous during the year to come as it has been during the year now closed. (Applause.)

THANKS TO THE BOARD OF EDITORS.

Mr. Noyes. I would like to say a word or two at this time. We all have received during the past year copies of the Journal. Probably all the members are more or less conversant with the large amount of labor which has devolved upon the Board of Editors, and we all know by the results which have been shown by the Journal how efficiently that labor has been performed. I feel that we owe a great debt of gratitude to our Editors, and that they have greatly advanced the interests of the Association by the heartiness and faithfulness with which they have entered into their work. I would now move a vote of thanks to them for it.

Adopted.

AN INVITATION TO DR. LEEDS.

Mr. Noyes. Now, if it is not out of place, and if I may ask the indulgence of the Association a few minutes longer. I would say I regretted exceedingly the arrival of the hour of adjournment this afternoon, because the topic then under discussion was exceedingly interesting, and it is rarely we have with us a man who has given such close study to the subject of purification and aeration and filtration of water as has Dr. Leeds, who then addressed us. There were some questions I wished to ask him, and I think he can give some information which would be of much value to the Association; and I would suggest that we wait a few moments longer now to enable him to speak to us again and answer some of the questions that are perplexing many of the water works officials of New England. As you are aware, many of our water supplies are derived from subterranean sources, and when the water is exposed to the air it undergoes a change and is affected by algæ in some form or other. I can call to mind several works which are unable during a portion of the year to use the water after it has been exposed. It has been suggested that possibly Dr. Leeds' studies or observations have gone so far that he can give us some light as to some methods of remedying the difficulty, other than by covering the water so as to keep it away from the light. The Superintendent of the Brookline works has told me he is unable, during most of the year, to use the water after it has been standing, so he pumps directly into the pipes sixteen hours a day, and the consumption is so small during the other eight hours that so little gets from the reservoir that it does not materially affect the quality of the water. I know of other works where they have the same trouble. Will Dr. Leeds be kind enough to give us a little information on that subject?

Dr. Leeds. I do not know exactly what to say, Mr. Chairman, in response to this kind invitation. I do not think I ought to to speak at present. You are at the end of a very long and full session, and I do not think I ought to detain you now. The subject is under study and very hard study. There is not a day but what these questions are brought to me,

and, Mr. President, if the members of the Association who have so kindly listened to me to-day desire it and feel an interest in this matter, I will do this: Next year, if in the interval you will bring to my notice the local conditions in the various places where your labors are engaged, I will promise to give the most faithful study I can to the subject and will bring forward the results before the Association. I do not think at the present time the data are sufficient and satisfactory enough for me to speak with that degree of confidence with which one ought to speak on a matter of great scientific and practical importance. And with great feeling of gratitude to the gentleman who has so kindly and flatteringly spoken, I would, Mr. President, be very glad to be excused from speaking further on this topic to-night, and hope that during the year I may be able to put the matter into such shape that I can present at your next annual meeting something worthy of your attention. (Applause.)

THANKS TO THE SECRETARY.

Mr. Coggeshall. I move a vote of thanks be extended to our worthy Secretary for the efficient manner in which he has discharged his duties during the past year.

Adopted.

On motion of Mr. Coggeshall the Convention then dissolved.

FRIDAY'S EXCURSION.

Not least among the reasons which the Association has for remembering its visit to Manchester is the recollection of the hearty hospitality of the city as proffered by the various officials who joined us and assisted us in many ways to make our stay a pleasant one On Thursday afternoon we were driven about the city, calling at the comfortable and home-like looking residence of Supt. Walker, at two fire engine houses, at the residence of Commissioner Chandler, and at the Amoskeag reservoir.

On Friday we had an almost cloudless sky, balmy atmosphere, anddustless roads, when the city of Manchester entertained us at Fletcher's Island, Massabesic Lake. A more perfect day could not have been wished for and the thunder shower of the evening previous was frequently alluded to as the greatest benefit that could have happened to make the day what it was. The members of the Convention assembled promptly at 8 o'clock at the court house, where they found barges and barouches, and the procession of solid men were soon on their way to the lake. As a part of the programme, a halt was made at the pumping station, the party arriving there at 9.10 o'clock. The building and pump were thoroughly inspected and a lemonade refresment partaken of. At 9.30 o'clock the party embarked once more and after a 20 minutes' ride reached Fletcher's Island, where the members alighted and began to stroll in groups about the pretty spot. Those from out of town who had never visited the lake were astonished at its beauty and purity, and were much pleased with the fine scenery that the locality afforded. From the time of their arrival on the island until dinner the party amused itself in various ways, some taking to the boats for a row or a fishing excursion, others pitching quoits while there were many small

groups gathered here and there story telling or indulging in old-time reminiscences. Quite a number boarded the steamer Joe Cobb and were treated to an extended trip about the lake. The Manchester contingent of the City Government and invited guests came down on the 11 o'clock train, connecting with the steamer to the island. A detail of police consisting of Patrolmen Lake, McTiernan, Fellows and Reed were stationed at the bridge and around the shore to prevent the crossing or landing of those who had no tickets. At 12.30 o'clock the members of the Association and invited guests filed into the commodious dining pavilion, where plates had been laid for 300.

Rev. C. S. Murkland asked divine blessing at the table. It is perhaps unnecessary to remark that there was no water specified on the bill of fare. There was plenty of fish, however, and the water was near at hand. Mayor Hosley presided at the post-prandial exercises, and his opening remarks were followed by a sketch of the early history of the works by ex-Gov. Weston. The remarks that followed from Edwin Darling, President of the Association, ex-Gov. Frederick Smyth, Frank E. Hall of Quincy, Mass., Congressman McKinney, Mayor Bruce of Lawrence, Willard Kent of Woonsocket, R. I., Prof. A. R. Leeds of Hoboken, N. J., and R. C. P. Coggeshall of New Bedford, were all very "pat" and called forth applause.

After the post-prandial exercises about one-half of those present took the barges and carriages for home. Those remaining were treated to a trip around the pond, during which all points of interest were described. At 6 o'clock the last of the party embarked on the "Joe Cobb" and made connections with a special train, reaching the city in season for the out-of-town guests to catch the 7 o'clock train, thus concluding a day that will ever be remembered in the history of the Association.

OBITUARY.

MARTIN CORYELL whose death occurred at Lambertville, N. J., on the last day of November, 1886, was born on July 20, 1815, at New Hope, Bucks Co., Penn.

Mr. Coryell was elected a member of this Association at the New Bedford meeting on June 16, 1886, and was at the time of his death one of the oldest Civil Engineers in this country. He had a wide and varied experience, beginning in good schools and under the instruction of John Gummere of Burlington, N. J., a man eminent in his day as a mathematician and astronomer. Failing health interrupted his studies, and he was successively, a carpenter, an assistant to Canvass White, engineer of the Delaware & Raritan Canal, in the State service on the Delaware Division Canal, in the law office of B. H. Brewster of Philadelphia, and Supt. of the Schuylkill level of the Columbia R. R. In 1847 he returned to New Jersey, built a coal wharf at Bergen Point, and then entered the employ of the Raritan Canal Co. under Ashbel Welsh. In 1876 Mr. Coryell finally settled at Lambertville, N. J., where he successfully established the city water works in which he owned a controlling interest, and of which he was Engineer and Superintendent. He was a Director in the Amwell National Bank, was elected a member of the American Society C. E.'s Dec. 4, 1867, and was a member of the American Inst. of Mining Engineers.

This Association can but record its regret at being deprived of the opportunity to become intimately acquainted with a man whose experience covered more than fifty active, useful years.

The following members and guests were registered at headquarters during the Convention:

Robert C. P. Coggeshall, Superintendent, New Bedford, Mass.
Wm. R. Billings, Superintendent, Taunton, Mass.
Charles K. Walker, Superintendent, Manchester, N. H.
Arthur E. Stearns, Water Registrar, Manchester, N. H.
Frank E. Hall, Superintendent, Quincy, Mass.
James H. Hathaway, Water Registrar, New Bedford, Mass.
Albert S. Glover, Water Registrar, Newton, Mass.
Jonas M. Clark, Superintendent, Northampton, Mass.
W. H. Richards, Superintendent, New London, Conn.
Charles H. Baldwin, National Meter Co., Boston, Mass.
Edwin Darling, Superintendent, Pawtucket, R. I.
R. M. Gow, Superintendent, Medford, Mass.
M. M. Tidd, Civil Engineer, Boston, Mass.
Willard Kent, Superintendent, Woonsocket, R. I.
W. C. Wilcox, ex-Water Registrar, Waltham, Mass.
A. G. Pease, Superintendent, Spencer, Mass.
Nathaniel Dennett, Superintendent, Somerville, Mass.
M. C. French, Superintendent, Kingston, Mass.
J. H. Gamwell, Superintendent, Palmer, Mass.
S. S. Coolidge, Commissioner, Bellows Falls, Vt.
George E. Batchelder, Water Registrar, Worcester, Mass.
John G. Brady, Commissioner, Worcester, Mass.
John C. Kelley, National Meter Co., N. Y.
H. B. Winship, Ludlow Valve Co., Norwich, Conn.
Richard Pattee, Holyoke Hydrant Works, Holyoke, Mass.
C. W. S. Seymour, Superintendent, Hingham, Mass.
W. H. Thomas, Commissioner, Hingham, Mass.
George J. Ries, Superintendent, Weymouth, Mass.
A. B. Drake, City Surveyor, New Bedford, Mass.
William E. McClintock, City Engineer, Chelsea, Mass.
William M. Pitman, Commissioner, Lower Bartlett, N. H.
Phineas Sprague, Water Registrar, Malden, Mass.
William B. Sherman, Secretary Corliss Engine Co., Providence, R. I.
George H. Frost, *Engineering News*, New York City.
Phineas Ball, Civil Engineer, Worcester, Mass.
James E. Beals, Registrar, Middleboro, Mass.
William F. Codd, Superintendent, Nantucket, Mass.
George A. Stacey, Superintendent, Marlboro, Mass.
David B. Kempton, Commissioner, New Bedford, Mass.
F. H. Parker, Superintendent, Burlington, Vt.
Jason Giles, Chapman Valve Manufacturing Co., Boston, Mass.
E. L. Buss, Chapman Valve Manufacturing Co., Boston, Mass.
Robert J. Thomas, Superintennent, Lowell, Mass.
Albert F. Noyes, City Engineer, Newton, Mass.
George E. Winslow, Superintendent, Waltham, Mass.
C. W. Morse, Superintendent, Haverhill, Mass.
G. B. James, Jr., Commissioner, Haverhill, Mass.

Frank L. Fuller, Civil Engineer, Boston, Mass.
Dexter Brackett, Assistant City Engineer, Boston, Mass.
Desmond FitzGerald, Superintendent, Western Division, Boston, Mass.
W. F. Learned, Civil Engineer, Boston, Mass.
F. P. Stearns, Chief Engineer Massachusetts State Board of Health, Boston, Mass.
A. H. Brodrick, Chadwick Lead Works, Boston.
H. W. Humphrey, Commissioner, Weymouth, Mass.
H. A. Nash, Commissioner, Weymouth, Mass.
W. H. Foster, Whittier Machine Company, Boston, Mass.
James P. Roberts, ex-Pumping Engineer, Lowell, Mass.
J. T. Murphy, Commissioner, Marlboro, Mass.
R. D. S. Mortimer, Commissioner, Marlboro, Mass.
B. Frank Polsey, Walworth Manufacturing Co., Boston, Mass.
W. T. Dotten, Superintendent, Winchester, Mass.
F. F. Forbes, Superintendent, Brookline, Mass.
Solon M. Allis, Superintendent, Malden, Mass.
G. A. Polsey, Sumner & Goodwin, Boston, Mass.
George E. Evans, ex-City Engineer, Lowell, Mass.
Benjamin S. Babcock, Superintendent, Nashua, N. H.
R. R. Yates, Superintendent, Northboro, Mass.
Edward H. Rice, Walworth Manufacturing Co., Boston, Mass.
A. N. Hyde, Jr., Superintendent, Newton, Mass.
M. A. Ewell, Commissioner, Haverhill, Mass.
Weaver Osborne, Commissioner, Fall River, Mass.
William M. Harris, Commissioner, Fall River, Mass.
Patrick Kieran, Superintendent, Fall River, Mass.
W. W. Robertson, Registrar, Fall River, Mass.
L. L. Fuller, ex-Commissioner, Malden, Mass.
Professor Albert R. Leeds, Stevens Institute, Hoboken, N. J.
L. C. Lamphear, Davidson Steam Pump Co., Boston, Mass.
George Woodman & Co., Boston, Mass.
E. M. Bixby, Deane Steam Pump Co., Boston, Mass.
Thomas Smith, Commissioner, Chelsea, Mass.
Randolph Brandt, New York city.
C. A. R. Dimon, Commissioner, Lowell, Mass.
Daniel Murphy, Commissioner, Lowell, Mass.
H. H. Knapp, Clerk Water Board, Lowell, Mass.
Miles F. Brennan, Commissioner, Lowell, Mass,
Hiram Nevons, Superintendent, Cambridge, Mass.
E. A. Wood, Newton, Mass.

Membership Roll.

ACTIVE MEMBERS—RESIDENT AND NON-RESIDENT.

Allen, Charles A., City Engineer, Worcester, Mass.
Allen, Charles F., Treasurer, Hyde Park, Mass.
Allis, Solon M., Superintendent, Malden, Mass.

Babcock, Benjamin S., Superintendent, Nashua, N. H.
Babcock, Stephen E., Hydraulic Engineer, Little Falls, N. Y.
Batchelder, George E., Registrar, Worcester, Mass.
Bagnell, Richard W., Superintendent, Plymouth, Mass.
Ball, Phineas, Civil Engineer, Worcester, Mass.
Baldwin, Charles H., Box 2410, Boston, Mass.
Barbour, Wm. S., City Engineer, Cambridge, Mass.
Barney, W. H., Superintendent, Milford, Mass.
Barnes, Everett, Superintendent, Westerly, R. I.
Battles, James M., Lowell, Mass.
Beals, Joseph E., Clerk and Registrar, Middleboro, Mass.
Bickford, Nathan B., Superintendent Water Works O. C. R. R., Boston, Mass.
Billings, Wm. R., Superintendent, Taunton, Mass.
Birkinbine, Harry, Superintendent, Council Bluffs, Iowa.
Bishop, George H., Civil Engineer, Middletown, Conn.
Boyce, W. C., Civil Engineer, 492 Main street, Worcester, Mass.
Brackett, Dexter, Assistant City Engineer, Boston, Mass.
Brady, John G., Commissioner, Worcester, Mass.
Brady, Thomas H., New Britain, Conn.
Brand, Junius A., Superintendent, Norwich, Conn.
Brinsmade, Daniel S., Civil Engineer, Birmingham, Conn.
Broatch, J. C., Superintendent, Middletown, Conn.
Brown, Arthur W. F., Registrar, Fitchburg, Mass.
Brown, Edward H., Superintendent, Nevada County N. G. R. R. Grass Valley, California.
Brown, Elbridge T., Civil Engineer, Brockton, Mass.
Brown, J. Henry, Superintendent Mystic Division, Charlestown, Boston, Mass.
Brush, Charles B., Engineer and Superintendent, Hackensack Water Co., Hoboken, N. J.

Caldwell, Joseph H., Registrar, Mystic Division, Charlestown, Boston, Mass.
Cate, E. W., Water Commissioner, Newton, Mass. Address 113 Devonshire street, Boston, Mass.

Chadbourne, E. J., Superintendent of Construction, Haverhill, Mass.
Chandler, Charles E., City Engineer, 161 Main street, Norwich, Conn.
Chaplin, W. S., Professor of Engineering, Harvard University, Cambridge, Mass,
Chase, John C., Superintendent, Wilmington, N. C.
Clark, Jonas M., Superintendent, Northampton, Mass.
Coburn, Walter, Lowell, Mass.
Cochran, Robert L., Superintendent Water Works, Nahant, Mass.
Codd, William F. Superintendent. Nantucket, Mass.
Coggeshall, R. C. P., Superintendent, New Bedford, Mass.
Coolidge, S. S., Water Commissioner, Bellows Falls, Vt.
Crehore, Dr. C. F., Water Commissioner, Newton, Mass. Address Box 1252 Boston, Mass.
Croes, J. J. R., Civil Engineer, 13 William street, New York city.
Cutts, Hiram, Office Water Registrar, Boston, Mass.

Darling, Edwin, Superintendent, Pawtucket, R. I.
Davis, F. A. W., Vice President Water Co., Indianapolis, Ind.
Davis. F. R , Athol, Mass.
Decker, J. H., Superintendent, Hannibal, Mo.
Denman, A N., Secretary and Treasurer Water Works, DesMoines, Iowa.
Dennett, Nathaniel, Superintendent, Somerville, Mass.
Dewson, F. A., Water Commissioner, Newton, Mass. Address Box 1534 Boston, Mass.
Diven, J. M., Secretary and Treasurer Water Co., Elmira, N. Y.
Dixon, William, Superintendent, Mt. Pleasant, Mich.
Dotten, William T., Superintendent, Winchester, Mass.
Drake, Albert B., City Surveyor, New Bedford, Mass.
Drake, B. Frank, Lake Village, N. H.

Ellis, George A., Civil Engineer, room 71 Equitable Building, Boston, Mass.

Fanning, John T., Hydraulic Engineer, Minneapolis, Minn.
Fitts, A. B., Water Registrar, Attleboro, Mass.
FitzGerald, Desmond, Superintendent, Western Division Boston Water Works, Brookline, Mass.
Forbes, F. F., Superintendent, Brookline, Mass.
French, Melvin C., Superintendent, Kingston, Mass.
Frierson, A. S., Superintendent and Engineer, Columbus, Miss.
Fteley, Alphonse, Consulting Engineer, New Croton Aqueduct Commission, Yonkers, N. Y.
Fuller, Frank L., Civil Engineer, 12 Pearl street, room 36, Boston, Mass.
Gamwell, J. H., Treasurer Water Co., Palmer, Mass.
Gardner, L. H., Superintendent, New Orleans, La.
Gerry, L. L., Civil Engineer, Stoneham, Mass.
Glover, Albert S., Water Registrar, West Newton, Mass.
Gow, Robert M., Superintendent, Medford, Mass.
Granniss, Sherman E., Superintendent, New Haven, Conn.
Grush, Benjamin S., Superintendent, Salem, Mass.

Haggett, Albert A., Lowell, Mass.
Hall, Frank E., Superintendent, Quincy, Mass.
Hammatt, E. A. W., Civil Engineer, 5 Pemberton Square, Boston, Mass.
Hancock, Joseph C., Superintendent, Springfield, Mass.
Hancock, William, President Water Board, Trenton, N. J.
Harding, Walter H., Water Registrar, Cambridge, Mass,
Harrington, John L., 84 Chestnut street, Cambridge, Mass.
Harris, John, Water Commissioner, Waltham, Mass.
Hastings, V. C., Superintendent, Concord, N. H.
Hathaway, James H., Water Registrar, New Bedford, Mass.
Hawes, William M., Water Commissioner, Fall River, Mass.
Hawkes, Ward, W., Malden, Mass.
Heald, Simpson C., Civil Engineer, 31 Milk street, Boston, Mass.
Hering, Rudolph, Chief Engineer Drainage and Water Supply Commission, Chicago, Ill.
Heermans, H. C., Superintendent, Corning, N. Y.
Henderson, Wilson, Superintendent, Peterborough, Ontario, Canada.
Hicks, R. S., Secretary, Stafford Springs, Conn.
Hildreth, Milo, Water Registrar, Northboro, Mass.
Hill, William F., Superintendent, Dedham, Mass.
Hitchcock, C. C., Water Commissioner, Ware, Mass.
Hodge, Thomas A. North Adams, Mass.
Holden, Horace G., with Turner, Clark & Rawson, 50 State street, Boston, Mass. Address, Lowell, Mass.
Holman, M. L., Principal Assistant Engineer, St. Louis, Mo.
Horan, David W., Boston, Mass.
Howland, A. H., Civil Engineer, room 71 Equitable Building, Boston, Mass.
Hull, B. H., Civil Engineer, Bridgeport, Conn.
Hyde, Horatio N., Jr., Superintendent, Newton, Mass.

Inman, A. W., with A. H. Howland, Equitable Building, Boston, Mass.

Jones, R. A., Superintendent, Spokane Falls, Washington Territory.
Jordan, Nathaniel, 1., Treasurer, Auburn, Me.
Joy, Moses Jr., Milford, Mass.

Kempton, David B., Water Commissioner, New Bedford, Mass.
Kent, Willard, Superintendent, Woonsocket, R. I.
Kieran, Patrick, Superintendent, Fall River, Mass.
Kimball, George A., Civil Engineer, 194 Washington street, Boston, Mass.
Knapp, Horace H., Clerk Water Board, Lowell, Mass.
Knapp, Louis H., Superintendent, Buffalo, N. Y.

Lane, Addison, Superintendent, Melrose, Mass.
Learned, Wilbur F., Civil Engineer, Watertown, Mass.
Leeds, Albert R., Professor Chemistry, Stevens Institute, Hoboken, N. J.
Lovell, Thomas C., Superintendent, Fitchburg, Mass.
Lyon, James W., with Turner, Clark & Rawson, 50 State street, Boston, Mass.

Martin, A. E., Superintendent, South Framingham, Mass.
Martin, Cyrus B., Treasurer Water Co., Norwich, N. Y.
Martine, Alfred H., Superintendent, Knoxville, Tenn.
Mason, Marshall, Superintendent, St. Albans, Vt.
McClintock, W. E., City Engineer, Chelsea, Mass.
Molis, William, Superintendent, Muscatine. Iowa.
Morse, Charles W,, Superintendent, Haverhill, Mass.
Morse, James W., Superintendent, Natick, Mass.
Murdock, Gilbert, Chief Engineer and Superintendent, St. Johns, N. B.
Miles, Alvoid O., Providence, R. I.

Nason, William E. Superintendent, Franklin, Mass.
Nettleton, Charles H., Superintendent, Birmingham, Conn.
Nevons, Hiram, Superintendent, Cambridge, Mass.
Northend, Charles A., New Britain, Conn.
Noyes, Albert F., City Engineer, West Newton, Mass.

Osborne, Weaver, Water Commissioner, Fall River, Mass.

Parker, F. H. Superintendent, Burlington, Vt.,
Pease, A. G , Superintendent, Spencer, Mass.
Perkins, John H., Superintendent, Watertown, Mass.
Pettengill, Amos, Superintendent, Woburn, Mass.
Phipps, Edward H., Superintendent West Haven Water Co., New Haven, Conn.
Pitman, Winthrop M., Proprietor Water Works, Lower Bartlett, N. H.
Porter, James, Greenfield, Mass.

Ries, George J., Superintendent, East Weymouth, Mass.
Rice, L. Fred, Civil Engineer, 4 Pemberton Square, Roston, Mass.
Richards, Walter H., Superintendent, New London, Conn.
Robertson, W. W., Water Registrar, Fall River, Mass.
Rogers, Henry W., Agent for Maxey & Lewis, Waterville, Me.
Rotch, William, Civil Engineer, 8 Exchange Place, Boston, Mass.
Russell, Daniel, Clerk Water Works, Everett, Mass.
Ryle, William, Superintendent, Paterson, N. J.

Schleiter, Henry L., Meriden, Conn.
Schwenk, William, President Water Co., Mt. Carmel, Pa.
Seymour, Chas. W. S., Superintendent, Hingham, Mass.
Sherman, William B , Mechanical Engineer, Providence, R. I.
Smith, Solon F., Superintendent, Grafton, Mass.
Sprague, Phineas, Water Registrar, Malden, Mass.
Stacy, George A., Superintendent, Marlboro, Mass.
Stanhope, H. R. Supt. of Water Works Construction, Springfield, Mass.
Stearns, Arthur E., Water Registrar, Manchester. N. H.
Stearns, Frederic P., Chief Engineer, State Board of Health, 13 Beacon street, Boston, Mass.
Swain, Geo. F., Professor of Civil Engineering Mass. Inst. of Technology, Boston, Mass.

Taylor, Lucien A., Civil Engineer, with W. C. McClallan, U. S. Hotel, Boston, Mass.

Tenny, Joseph G.. Superintendent, Leominster, Mass.
Tidd, M. M., Hydraulic Engineer, 10 Tremont street, Boston, Mass.
Tower, D. N., Constructing Engineer, Cohasset, Mass.
Truesdale, C. H., Civil Engineer, Central Village, Conn.
Walker, Charles K., Superintendent, Manchester, N. H.
Wescott, Geo. P., Treasurer Water Co., Portland, Me.
Whidden, Hosea F., Whitman, Mass.
Whitcomb, W. H., President Water Co., Norway, Me.
Whitlock, Frank W., Civil Engineer, Waterbury, Conn.
Wild, George E., Superintendent, Sterling, Ill.
Whitney, John C., Superintendent Meter Department, West Newton, Mass.
Whittemore, W. P., Superintendent, North Attleboro, Mass.
Wigal, J. P., Superintendent, Henderson, Ky.
Wilcox, William C., Waltham, Mass.
Wilson, James, Manager and Engineer, Kingston, Canada.
Winship Horace B., Civil Engineer, Norwich, Conn.
Winslow, Geo. E., Superintendent Water Works, Waltham, Mass.
Winslow, S. J., Superintendent, Pittsfield, N. H.

Yates, Richard R., Superintendent Water Works, Northboro, Mass.

HONORARY MEMBERS.

Frost, George H., Engineering News, Tribune Building, New York City.

Meyer, Henry C., Sanitary Engineer and Construction Record, 82 Fulton Street, New York City.

ASSOCIATE MEMBERS.

Asbestos Packing Co., 169 Congress Street, Boston, Mass.
Ashton Valve Co., Water Relief Valves, 271 Franklin St., Boston, Mass.

Blake, George F. Mfg. Co., Pumping Engines, 113 Federal Street, Boston, Mass.
Boston Lead Mfg. Co., 162 Congress Street, Boston, Mass.
Brandt, Randolph, Selden Patent Packing, 38 Cortlandt Street, New York City.

Chadwick Lead Works, 171 High Street, Boston, Mass.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Cunningham Iron Works, 109 Milk Street, Boston, Mass.
Curley, Thomas, Boston, Mass.
Curtis Regulator Co., "Pressure Regulators," 59 Beverly Street, Boston, Mass.
Coffin Valve Co., 295 South Street, Boston, Mass.

Davidson Steam Pump Co., 77 Liberty Street, New York City.
Deane Steam Pump Co., Holyoke, Mass.

Equitable Water Meter Co., 33 India Wharf, Boston, Mass.

Fiske, Wilbur D., Knowles Steam Pump Co., 113 Federal Street, Boston Mass.

Franklin, Albert B., Steam Heating Apparatus, 30 Charlestown, Street, Boston, Mass.

Frost & Adams, Architects' Supplies, 37 Cornhill, Boston, Mass.

Gallison, W. H., Engineers Supplies, Pipe, etc, 42 Oliver Street, Boston, Mass.

Giles, Jason, Chapman Valve Mfg. Co., Indian Orchard, Mass.

Gowing, E. H., (Henry R. Worthington Co.,) 70 Kilby Street, Boston, Mass.

Hartford Meter Co., 336 Asylum Street, Hartford, Conn.

Jenkins Bros., Valves and Packing, 105 Milk Street, Boston, Mass.

Jenks, Henry F., Drinking Fountains, Pawtucket, R. I.

Langford, John T., Contracting Engineer, 70 Kilby Street, Boston, Mass.

Ludlow Valve Mfg. Co., Troy, N. Y.

McClallan, W. C., Contractor, U. S. Hotel, Boston, Mass.

Marsh, W. H., Tuerk Motor Co., 12 Cortlandt Street, New York City.

Morton, A. M., Pipe and Fittings, 25 Washington Street, Boston, Mass.

Mudge, B. C., (H. R. Worthington Co.,) 70 Kilby Street, Boston, Mass.

National Meter Co., 252 Broadway, New York City.

National Tube Works Co., Pipe and Fittings, McKeesport, Pa.

Newman, J. J. & Co., Contractors, 19 Wilson Street, Providence, R. I.

Pancoast & Rogers, Pig Iron, Iron Pipe, Etc., Gold, cor. Platt Street, New York City.

Pattee & Draper, Fire Hydrants, Holyoke, Mass.

Peet Valve Co., 163 Albany Street, Boston, Mass.

Providence Cylinder Co,. Steel Pipe, 58 Warren Street, Providence, R. I.

Robinson, R. A., Jr., Agent Builders Iron Foundry, P. O. Box 218, Providence, R. I.

Root, W. J., Hydraulic Engineer, (H. R. Worthington Co.) 86 Liberty Street, New York City.

Sampson, Geo. H., Powder, 231 State Street, Boston, Mass.

Spooner, D. Brainard, Spooner Meter Co., Sears Building, Boston, Mass.

Sumner & Goodwin, Pipe and Fittings, 21 Oliver Street, Boston, Mass.

Tilden, J. A., Hersey Meter Co., South Boston, Mass.

Tarr, H. G. H., Civil Engineer, (H. R. Worthington Co.) 86 Liberty Street, New York City.

Union Water Meter Co., 31 Herman Street, Worcester, Mass.

Upton, Albert F., Jarvis Engineering Co., 61 Oliver Street, Boston, Mass.

Waldo Bros., Contractors' Supplies, 88 Water Street, Boston, Mass.

Walworth Mfg Co., Pipe and Fittings, 16 Oliver Street, Boston, Mass.

Ward, W. H., (W. H. Ward & Co.,) Plumbers Supplies, 140 Oliver Street, Boston, Mass.

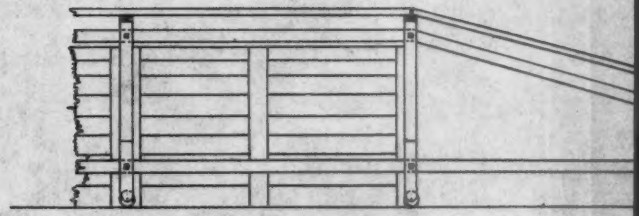
Wood, R. D. & Co., Cast Iron Pipe, 400 Chestnut St., Philadelphia, Pa.

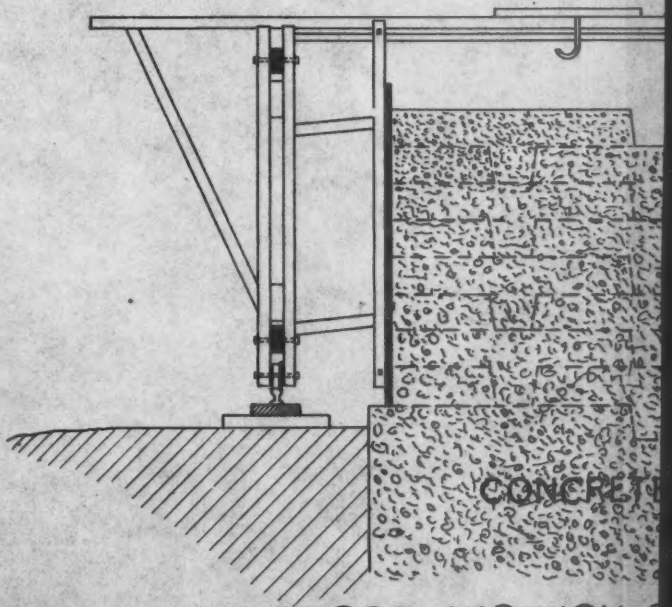
Woodman, Geo. & Co., 41 Pearl Street, Boston, Mass.

Whittier Machine Co., Gates and Hydrants, Granite, cor. First Street, South Boston, Mass.

Worthington, Co H. R., Steam Pumps, 86 Liberty Street, New York City.

PLAN

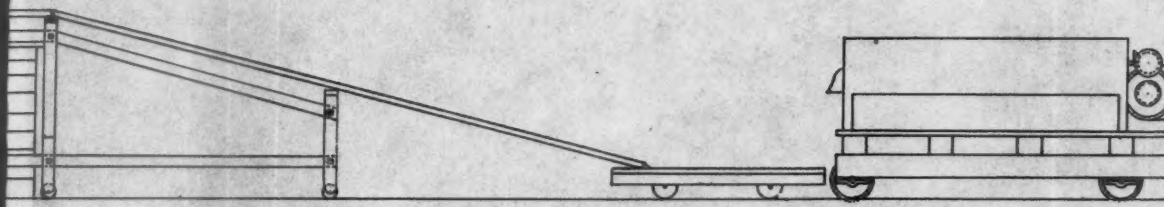




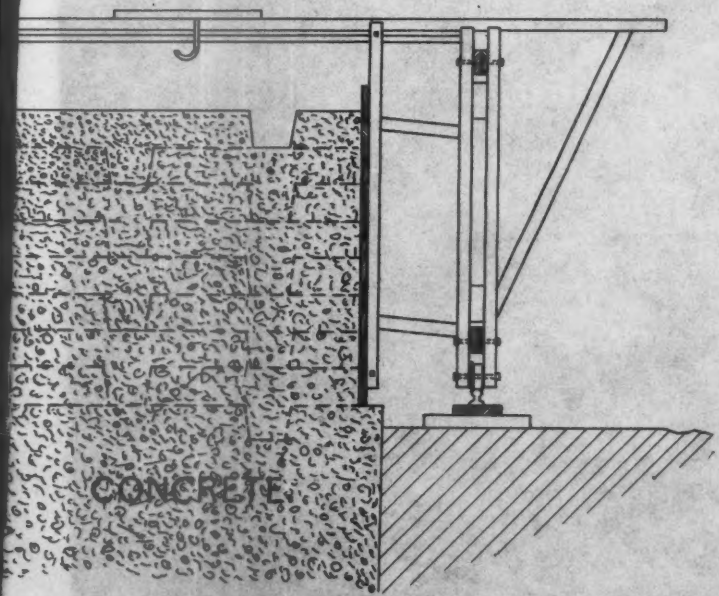
CROSS SECTION

Forbes Co. Boston.

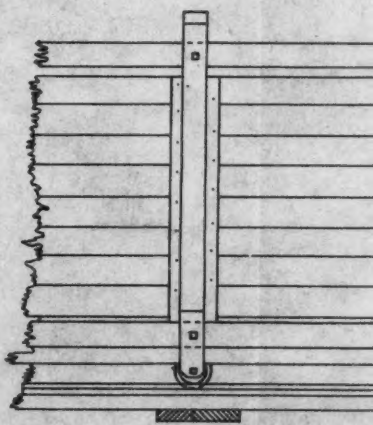
PLAN SHOWING METHOD OF BUILDING CONCRET



GENERAL ELEVATION.

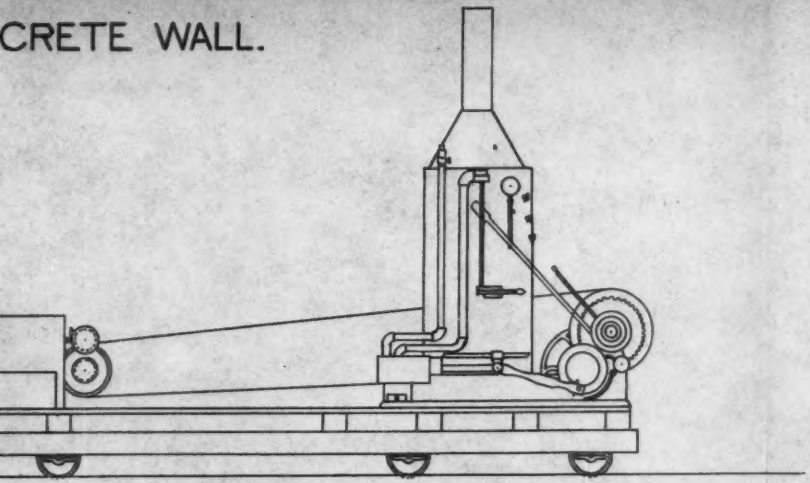


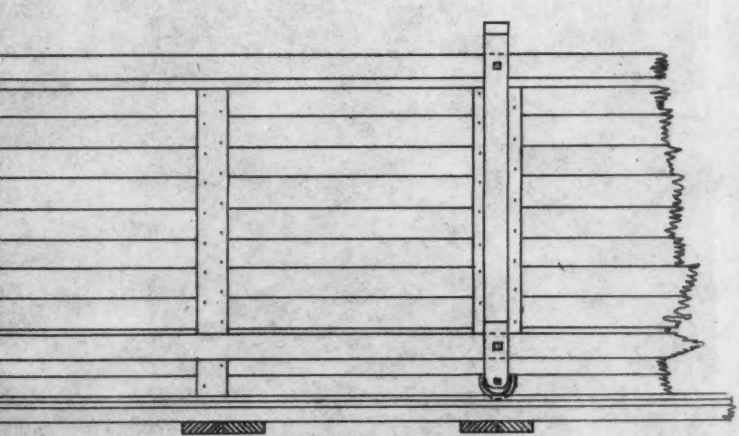
S SECTION OF FRAME.



ELEVA

CRETE WALL.





ELEVATION OF FRAME.

Table of Contents.

Papers.

Ashland Basin No. 4 and the Mixing and Handling of Concrete, Wilbur F. Learned, C. E..... 3

On the Capacity of the Sudbury River and Lake Cochituate Water Sheds in time of Drought, Desmond FitzGerald, C. E..... 12

Fall Meeting 33

Exchange of Sketches..... 34

Obituary—Phineas Sprague 35

Advertisements.

CORRECTION.

Mr. Tidd has called our attention to errors in the report of his remarks at the Manchester meeting. In vol. 2, No. 1, page 28, and 20th line from top, the words should be "when you get down to within two or three feet of the cement" etc.